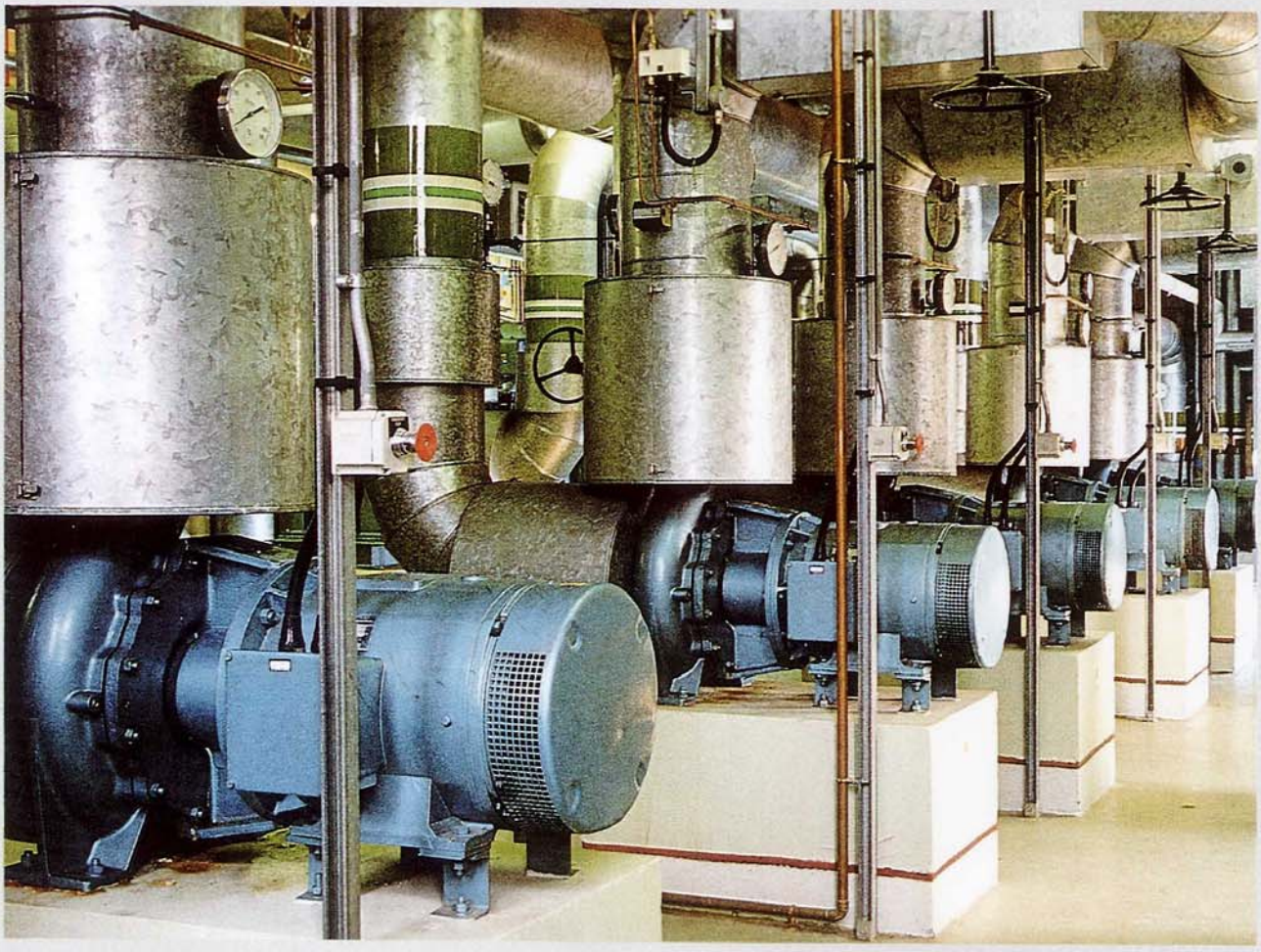
Specification 036

Heating, hot and cold water, steam and gas installations for buildings - formerly PSA Standard Specification (M&E) No 3



DEFENCE ESTATE ORGANISATION
MINISTRY OF DEFENCE

Specification 036

Heating, hot and cold water, steam and gas installations for buildings

This specification supersedes the former PSA Standard Specification (M & E) No. 3

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INDUSTRIAL PROCESSES GROUP
DEFENCE ESTATE ORGANISATION

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Foreword

1. This Specification is one of a series prepared by the Defence Estate Organisation primarily for use in its contracts for mechanical and electrical engineering works. The Specification covers the installation of heating, hot and cold water, steam and gas services for buildings other than dwellings. It is a revision of the former Standard Specification (M&E) No. 3, dated 1988, and Guidance Notes for Users, dated 1990.

2. When this Specification is used in connection with a Defence contract then it is to be read in conjunction with such further documents setting out contractual requirements particular to the contract.

3. Whilst this Specification was commissioned by the DEO for use on MOD contracts, it is acknowledged that it could be usefully applied to other contracts. DEO commends its use to other Government departments.

   It may therefore be used outside the MOD estate. However, no warranty is given as to the accuracy of this Specification or its fitness for any purpose.

4. This Specification has been devised for the use of the Crown and its contractors in the execution of contracts for the Crown. The Crown hereby excludes all liability (other than liability for death or personal injury) whatsoever and howsoever arising (including, but without limitation, negligence on the part of the Crown, its servants or agents) for any loss or damage however caused where the document is used for any other purpose.

Abbreviations

The following abbreviations are used in this specification:

BC	British Coal
BEWA	British Effluent and Water Association
BGC	British Gas Corporation
BS	British Standard
BSEN	British Standard Euro Norm
BSP	British Standard Pipe thread
CIBSE	Chartered Institution of Building Services Engineers
BSCP	British Standard Code of Practice
CP	Competent Person
CWS	Cold water supply
DHWS	Domestic hot water service
DEO	Defence Estate Organisation
ERW	Electric Resistance Welded
GCV	Gross calorific value
GRP	Glass reinforced plastics
HTHW	High temperature hot water
HVCA	Heating and Ventilating Contractors Association
IEE	Institution of Electrical Engineers
IGE	Institution of Gas Engineers
ISO	International Standards Organisation
LED	Light emitting diode
LPG	Liquefied petroleum gas
LTHW	Low temperature hot water
MCR	Maximum continuous rating
MTHW	Medium temperature hot water
NJIC	National Joint Industrial Council
NR	Noise rating
NRA	National Rivers Authority
PM	Project Manager
PS	Particular specification
S	Seamless
TRY	Thermostatic radiator valve

Amendments

Please use this table to make a note of any amendments issued.

Amendments	Page No	Date	Inserted by

Section One—General Requirements

1.1 SCOPE

1.1.1 This Specification details the design and other requirements for low, medium and high temperature hot water heating installations, domestic hot and cold water supplies, steam and condensate, gas and oil fuel services and fire protection systems, for buildings.

1.1.2 Unless otherwise indicated, the work shall include design, manufacture, works testing, supply, delivery to site, installation, site testing, commissioning, making good any defects that occur during the defect liability period, provision of As Installed drawings and Operation and Maintenance documents, the whole of the labour, and all materials necessary to form a complete installation (whether or not all the necessary components are indicated). The work will also include any Scope of Work forming part of a Particular Specification attached to the Contract.

1.1.3 Where indicated, the work shall include comprehensive planned preventive maintenance for a period of 12 months following acceptance of the completed installation.

1.2 DEFINITIONS

1.2.1 Where the work is to be undertaken as a sub-contract, 'Contractor' shall mean 'Sub-contractor'.

1.2.2 'Indicated' as used in 'as indicated', 'where indicated', 'unless otherwise indicated' and like phrases shall mean indicated in Schedule No. 1 of this Specification or in the other documents listed in the invitation to tender.

1.2.3 'Approval' (and words derived therefrom) means approval in writing by the PM, unless stated otherwise.

1.2.4 Commissioning. The advancement of an installation from the stage of static completion to full working order to specified requirements. Commissioning includes the setting to work and regulation of an installation.

a) Setting to work. The process of setting a static system into motion.

b) Regulation. The process of adjusting the system operating criteria to the specified requirements.

1.2.5 Site Performance Testing. The evaluation of the performance of a commissioned installation.

1.2.6 Low temperature hot-water (LTHW) system. A system which operates at a maximum temperature of 100°C and a minimum flow temperature of 70°C but which is not part of an MTHW or HTHW injection system.

1.2.7 Medium temperature hot-water (MTHW) system. A pressurised system, either open or closed to the atmosphere, which operates at temperatures above 100°C and up to 120°C.

1.2.8 High temperature hot-water (HTHW) system. A pressurised system closed to the atmosphere which operates at temperatures above 120°C.

1.2.9 Steam services. Steam heating and/or distribution systems with working gauge pressure up to a maximum of 10 bar.

1.2.10 Gas, either manufactured gas (1st family), natural gas (2nd family), or LPG (3rd family) as indicated.

1.2.11 Pipework sizes.

a) DN shall refer to the nominal bore of steel tubes (mm). Copper tube sizes shall be referred to by outside diameter in mm.

b) Pipes, pipe fittings and valves designated 'SIZE 1' etc., shall refer to items with threaded BSP connections to BS 21.

c) Pipes, pipe fittings and valves designated 'DN 50', 'DN 65' etc., shall refer to items whose bore sizes are nominally 50mm, 65mm, etc.

1.3 RELATED DOCUMENTS

1.3.1 This Specification shall be read in conjunction with, and its requirements are in addition to, the general conditions of contract and any drawings and other documents issued with it and listed in the invitation to tender.

1.3.2 Any discrepancy between this Specification, the Conditions of Contract, other documents listed on the tender form or the Contract Drawings shall be referred to the relevant person designated in the tender documents as soon as practicable during pre-acceptance stage, or to the PM thereafter.

1.4 PROVEN PERFORMANCE

1.4.1 Systems and equipment selected by the Contractor shall have performed successfully for not less than 2 years under the same conditions as those required by the tender documents.

1.4.2 Systems and equipment that do not comply with the foregoing proven performance requirement may be considered, provided full technical details and evidence of suitability are given at the time of tendering.

1.5 STANDARDS

1.5.1 Commodities specified to conform to British Standards shall be clearly and indelibly marked with the reference specified. Where this is impracticable, the relevant advice and delivery notes shall include the BS reference with which they are to comply.

1.5.2 Where commodities are specified as manufactured by a BSI Kitemark Licensee or where commodities/services are specified to be Registered Firms (under BSI Assessment Schemes), the manufacturer/firm must be a current participant in the relevant scheme.

1.5.3 Where commodities or systems are specified as certified by the British Board of Agrement, the commodities or systems supplied shall be the subject of a current BBA Certificate.

1.5.4 Where commodities/services are specified to be by registered/approved firms (under Approved Quality Assurance Schemes), the manufacturer/firm must be a current participant in the relevant scheme.

1.5.5 The equipment and/or installation(s) shall conform to the relevant British Standards and Codes of Practice current 3 months prior to the date for return of tenders, unless otherwise indicated. Certificates of compliance with British Standards, BSI Certification Schemes, and/or Quality Assurance Schemes, shall be provided to the PM at his request.

1.5.6 Materials and fittings for domestic hot water and cold water systems shall be as listed in the Water Research Centre's 'Water Fittings and Materials Directory' or, where not listed, shall comply with the requirements of the particular Water Company.

1.5.7 Gas fired equipment and appliances shall comply with the requirements of the Gas Safety (Installation and Use) Regulations.

1.6 REGULATIONS

1.6.1 All work shall be carried out in accordance with the MOD relevant Safety Regulations and Procedures which may be seen on request to the PM.

1.6.2 The installation(s) shall comply with and be subject to all relevant Statutory Instruments, Regulations, and special Guidance and Memoranda which include the following:

a) The Health and Safety at Work, etc., Act.

b) Regulations under the Electricity Acts.

c) The Electricity at Work Act.

d) The Clean Air Act.

e) Control of Pollution Act.

f) Energy Conservation Act.

g) Regulations under the Factories Act.

h) The Building Regulations.

j) The Gas Safety (Installation and Use) Regulations.

k) The Control of Substances Hazardous to Health Regulations (COSHH).

1) The Pressure Systems and Transportable Gas Container Regulations.

m) The Construction (Design and Management) Regulations (CONDAM).

n) The Management of Health and Safety at Work Regulations (MHSW).

o) The Personal Protective Equipment at Work Regulations (PPE).

p) BS 7671 : 1992 (Requirements for electrical installations. The IEE Wiring Regulations).

q) British Gas Corporation Codes of Practice.

r) The Institution of Gas Engineers utilization procedures (IGE/UP)

s) Any special requirements of the Local Electricity, Gas or Water Companies and Fire Fighting Authority.

t) The Asbestos Regulations.

u) The Boiler (Efficiency) Regulations.

v) HSE Guidance Note HS(G)70—The control of legionellosis (including Legionnaires' disease).

w) CIBSE Technical Memoranda TM13:1991—Minimising the risk of Legionnaires' Disease.

1.6.3 The tender shall be based on the Regulations current 3 months prior to the date for return of tenders.

1.7 DRAWINGS

1.7.1 Working Drawings

1.7.1.1 Unless otherwise indicated, the Contractor shall provide working drawings for comment before manufacture or installation. The drawings shall show:

a) Fully dimensioned builder's work requirements.

b) Details of plant rooms.

c) General arrangement of complete installation.

d) Details of any changes resulting from Instructions given by the PM or agreements reached with him.

e) Diagrams separately showing in detail all the electrical circuit and wiring layouts and/or, where applicable, the pneumatic circuitry within the installation.

f) Layouts and details of control panels and cubicles.

g) Manufacturers' 'as made' drawings where required by the Specification.

1.7.1.2 With the agreement of the PM, holes, fixings, etc., other than in plant rooms, may be marked out on site instead of on drawings.

1.7.1.3 An initial set of drawings described in Clause 1.7.1.1 shall be sent to the PM for comment within five weeks of the acceptance of the tender.

1.7.2 ELECTRICAL, ELECTRONIC AND PNEUMATIC DIAGRAMS

1.7.2.1 Electrical, electronic and pneumatic diagrams shall comply with the following:

a) Composite circuit and layout diagrams for electrical, electronic and pneumatic services shall detail all circuitry within main control panels and also connection diagrams for all external equipment eg. starters, thermostatic and pneumatic controls devices, all automatic firing and mechanical draught equipment, together with all inter-connecting wiring or pipework from the main point of supply onwards, and all terminal markings.

b) The sizes and types of all cables and pipes shall be indicated on the layout diagrams, together with the ratings of all items such as fuses, switches, valves, controllers, etc.

c) Circuit diagrams shall, where possible, be so arranged that the main sequence of events is from left to right and from top to bottom of the diagram. Diagrams shall generally comply with BS 3939—Graphical symbols for electrical power, telecommunications and electronic diagrams.

d) Where abbreviations are employed for the designation of components a schedule shall be provided on the drawings to explain their meanings.

e) A print of each of the composite circuit and layout diagrams shall be fixed securely to the inside of the hinged front of the main electrical and pneumatic control panels, as appropriate, or in such other positions as may be agreed with the PM and shall be

protected by non-flammable transparent material. Where inadequate space exists the prints shall be suitably reduced in size.

f) Individual circuit and layout drawings from component manufacturers will not be accepted in lieu of composite diagrams.

1.7.3 'As Installed'Drawings

1.7.3.1 Unless otherwise indicated, the Contractor shall provide four sets of approved drawings which shall show the following, where applicable:

a) The complete installation including the sizes and routes of all pipework.

b) The precise location of all pipework which is buried within the structure and those sections of any external distribution pipework which are buried in the ground.

c) The precise positions of all underground cold-water and gas service points at the entry to buildings, giving their depth and the locations of the service isolating valves or cocks.

d) Any special thermal or other protecting envelopes around services which are buried.

e) The geographical location and identification number of each circuit control valve in accordance with the labelling and circuit control diagram required by Clauses 7.17.1 and 7.17.2.

f) The names of the manufacturers, model and type numbers and all details of duty and rating of all items of plant including automatic controls equipment.

1.7.3.2 Unless otherwise indicated, draft copies of these drawings shall be submitted to the PM, for approval, prior to completion of the Works. Final approved drawings shall be supplied to the PM not later than one month before the date for completion of the Works (or such other time as may be agreed with the PM). Failure to do so could cause delay in any release which it is considered may be made from the Reserve on the completion of the Works or during the maintenance period, and in the settlement of the final account.

1.7.3.3 Each drawing shall be in accordance with BS 308: Part 1 (to ensure suitability for micro-filming), and shall be a process negative on translucent material, not paper, of a standard size Al to A4. Where agreed by the PM microfiche copies or CAD disks in agreed format may be supplied.

1.7.3.4 The words 'AS INSTALLED' shall be inserted in 19mm block letters adjacent to the title block of each drawing, together with the name of the site, the building, the title of the installation, the contract number and the name of the Contractor. Each drawing shall be dated.

1.7.3.5 During the course of the Works, the Contractor shall maintain a fully detailed record of all changes from the initial Contract Drawings to facilitate easy and accurate preparation of the 'As Installed' drawings and to ensure that these drawings are in all respects a true record of the installation.

1.8 OPERATING AND MAINTENANCE DOCUMENTS

1.8.1 Unless otherwise indicated, the Contractor shall provide two separate copies of approved Health and Safety File, including: operating and maintenance documents, and a completed set of the planned maintenance data sheets for the whole of the installation covered by the Contract. These documents shall contain all relevant information for the safe operation and maintenance of the system. Where applicable, the supply of information shall accord with the relevant requirements of the Pressure Systems and Transportable Gas Containers Regulations.

1.8.2 Unless otherwise indicated, a draft copy of the document shall be submitted to the PM, for approval, prior to completion of the Works. Final approved documents shall be supplied to the PM not later than one month before the date for completion of the Works (or such other time as may be agreed with the PM). Failure to do so could cause delay in any release which it is considered may be made from the reserve on completion of the Works or during the maintenance period, and in the settlement of the final account.

1.8.3 Documents are to be bound in strong flexible and durable covers with four hole binding to accept standard punched A4 sheets to BS 5097: Part 1. Documents shall be indexed for ease of reference.

1.8.4 Operating and maintenance instructions may be designed to be read in conjunction with 'As Installed' drawings and shall include the following:

a) A general description of the scope, purpose and manner of working of each system or apparatus forming part of the Works.

b) Data on general setting of controls associated with controlling design conditions, monitoring instruments and switchgear.

c) Instructions for safe starting up, operating and shutting down of each system.

d) Instructions for dealing with fault diagnosis and remedial action of each system.

e) Any precautionary measures necessary for ensuring health and safety and avoidance of misuse.

f) Instructions for planned preventive maintenance to maintain the equipment in accordance with the manufacturers' recommendations.

g) The names and addresses of suppliers of all major components.

h) Spare parts lists for consumable components.

1.9 ELECTRICITY SUPPLY

1.9.1 Unless otherwise indicated all apparatus and wiring shall be suitable for use with a 3-phase, 4 wire, 400/230 volt 50 Hz earthed neutral system.

1.10 ELECTRICAL EQUIPMENT AND WIRING

1.10.1 Bonding of all extraneous conductive parts of the installation (including metallic pipework, insulation cladding etc.) shall be carried out in accordance with BS 7671 Requirements for electrical installations (The IEE Wiring Regulations).

1.11 PAINTING

1.11.1 Ferrous sheet metal work not galvanised shall have protective coats of primer paint and undercoat or other approved material before despatch from works. Other ferrous materials shall receive a protective coat at works where it is normal custom. Any deterioration or damage to manufacturers' protective coatings during storage, installation, and before Handover shall be made good by the Contractor to the satisfaction of the PM.

1.11.2 Unless otherwise indicated the Contractor shall be responsible for painting:

a) Condensate receivers, cisterns, tanks and hot wells (Clauses 3.3.7, 5.5.4, 5.6.1 and 5.7.1).

b) Oil storage tanks as required by BS 799: Part 5 and this specification.

c) Thermal insulation (Clauses 10.4.5.1 and 10.4.5.2).

d) Areas of deterioration or damage to manufacturer's protective coating as described in Clause 1.11.1.

1.11.3 The external surfaces of all ferrous metal work including pipework, hangers, supports etc., which are not to be insulated, and are not galvanised or otherwise protected against corrosion, shall be primed and finished with a paint system to BS 5493 as indicated. The surface of all ungalvanised ferrous pipework which is to be insulated, shall be finished with two coats of aluminium paint. The Contractor shall ensure that:

a) Surfaces are cleaned in accordance with all relevant parts of BS 7079 before they are painted.

b) Those parts of the installation required to be left unpainted (eg. brasswork) shall be so left.

c) The pipework services are correctly identified to ensure the use of approved paint of the correct colour to comply with BS 1710 and the PM's instructions.

1.11.4 When the Works covered by this Specification are carried out as a sub-contract the Sub-Contractor will apply the priming and finishing coats, unless otherwise stated.

1.12 ASBESTOS MATERIALS

1.12.1 Asbestos materials shall not be installed. This requirement applies to major items eg. thermal insulation and to sundry minor components such as gaskets, fire seals and valve packings.

1.13 CFCS AND HCFCS

1.13.1 Products containing and/or requiring the use of CFCs and HCFCs in their manufacture, will not be permitted.

1.14 SCHEDULES

1.14.1 Schedule No. 1 to this Standard Specification gives information to tenderers relating to the clauses where options or specific numbers etc. require stating.

1.14.2 Schedule No. 2 to this Standard Specification is for tenderers to complete and return as part of their tenders.

Section Two—Central Plant

2.1 BOILERS—GENERAL

2.1.1 These General Requirements shall apply in part or in whole to boilers described in this Section.

2.1.2 Boilers and associated firing equipment shall be of approved design and shall conform to the requirements as indicated.

2.1.3 All necessary fittings and equipment for automatic control shall be supplied with each boiler.

2.1.4 Each solid fuel boiler installation shall have one set of operating tools comprising heavy pattern steel shovel, scraper, slice bar, clinker tongs, wire flue brush and de-ashing rake, where applicable. Oil-fired and gas-fired boiler installations shall have a set of flue and tube cleaning tools appropriate to the boilers. The tools shall be hung on a rack supplied and fixed by the Contractor in a position indicated by the PM.

2.1.5 Where brick or concrete bases are to be provided by a Building Contractor, the Contractor shall provide all dimensions and details to enable the bases to be designed and set out. For boilers without water-cooled bottoms forming an integral part of the circulation, and for other boilers where indicated, an insulated and ventilated base will be provided by the Building Contractor to their design and for which the Contractor shall furnish all necessary information on dimensions and weights.

2.1.6 The thermal efficiencies of the boilers at maximum and minimum firing rates and at about midway between, as relevant, shall be not less than those indicated when the boilers are tested at completion. See Section 12.

2.1.7 Valving to boilers flow and return connections shall be to clauses 30.1 and 30.2 of BS 759: Part 1. Where additional valves are installed and are separated by a length of pipe, this length shall have a drain cock and air vent.

2.1.8 The heat release rate to each furnace tube based on fuel input (Gross Calorific Value—GCV) OR the nominal output at 80% efficiency shall not exceed 1800W/m^3. (Not steam boilers).

2.1.9 The hot face metal temperature of the first pass reversal chamber tube plate calculated to BS 2790 Appendix C shall not exceed 380°C.

2.1.10 The boiler shall operate satisfactorily using water with Total Dissolved Solids (TDS) up to 3500 ppm. (Not steam boilers).

2.1.11 Boiler exit gas temperatures generally shall not exceed 260°C. Boiler exit gas temperatures on oil-fired installations shall not fall below 180°C unless otherwise indicated.

2.1.12 The gas-side resistance between the fuel firing equipment and boiler exit shall not exceed 15 mbar.

2.1.13 For steam boilers the water surface area in the steam shell shall be sufficient to ensure that the steam disengagement velocity does not exceed 0.06 m/s at working pressure.

2.1.14 Steam at entry to the pressure main shall have a minimum Dryness Fraction (DF) of 0.98.

2.2 STEAM BOILERS

2.2.1 Water Tube Boilers

2.2.1.1 In addition to the requirements in Boilers-–General and those of BS 1113 the following shall apply:

a) The furnace shall be of membrane water-wall construction with a minimum of refractory material.

b) The heat release rate to the furnace from the stoker/burner shall be no greater than 362kW/m^3.

c) The boiler shall operate satisfactorily using water with total dissolved solids (TDS) up to 3000ppm.

d) A furnace observation port with sight glass of minimum diameter 50mm and protective shutter shall be provided.

2.2.2 Steel Shell, 3-Pass Economic Boilers

2.2.2.1 In addition to the requirements of BS 855 or BS 2790 as indicated, the following shall apply:

a) An observation port with sight glass of minimum diameter 50mm and protective shutter shall be provided for each furnace tube. The port shall be positioned at the rear of the gas reversal chamber to view the flame within the furnace tube. The sight glass and protective shutter shall be readily removable to permit the use of water-cooled suction pyrometers.

b) The attachment of tubes to the first-pass reversal chamber tube plate in shell boilers built to either BS 2790 or BS 855 shall be as follows:

Boilers built to BS 2790:
Stay tubes: Figure 3.9.2 (l)(d)
Plain tubes: Figure 3.9.2(l)(d) or Figure 3.9.2(2)(b)

Boilers built to BS 855:
Stay tubes: Figure 26(d)
Plain tubes: Figure 26(b) or Figure 26(d)

2.2.3 Steel Shell Reverse-Flame Boilers

2.2.3.1 In addition to the general requirements of BS 855 or BS 2790 as indicated, the following shall apply:

An observation port with sight glass of minimum diameter 50mm and protective shutter shall be provided for the furnace tube. The port shall be positioned to provide a view of the flame within the furnace tube. The sight glass and protective shutter shall be readily removable to enable the use of water-cooled suction pyrometers.

2.2.4 Continuous-Coil Steam Generators

2.2.4.1 In addition to the requirements of BS 1113 the following shall apply:

a) The overall boiler heat transfer rate based on the fuel input (gross calorific value) and 80% efficiency shall not exceed 70kW/m^2 of heating surface.

b) A dynamic steam separator shall be fitted and the steam at entry to the pressure main or common steam manifold shall have a minimum dryness fraction of 0.98.

c) Positive blow-down arrangements shall be provided for the water circuit and the boiler shall be capable of satisfactory operation using water having total dissolved solids (TDS) up to 3000ppm.

d) A furnace observation port complete with sight glass of minimum diameter 50mm and protective shutter shall be provided.

2.2.5 Electrode Boilers

2.2.5.1 In addition to the requirements of BS 1894 the following shall apply:

a) The boiler shell shall be of welded steel construction.

b) The steam at entry to the pressure main or common steam manifold shall have a minimum dryness fraction of 0.98.

c) The boiler shall be capable of delivering its rated output when operated with water of specific resistance not less than 500 ohm cm at 65°C, under normal operating pressure and with a feed water temperature of 15°C.

2.2.6 Waste Heat Boilers

2.2.6.1 In addition to the requirements of BS 855, BS 1113 or BS 2790 as indicated, the following shall apply:

a) The boiler shall be matched to the requirements of the installations producing the waste gas.

b) The boiler shall be capable of satisfactory operation using water having total dissolved solids (TDS) up to 3500ppm.

c) Boilers shall be capable of withstanding the passage of the hot waste gas when drained of water as indicated.

2.2.7 Electrical Resistance Heated Boilers

2.2.7.1 In addition to the requirements of BS 1894 or BS 5500, as indicated, the following shall apply:

a) The boiler shell shall be of welded steel construction.

b) The elements shall be of the heavy-duty copper or stainless steel sheathed wire type and shall be removable.

c) The boiler shall be thermally insulated and provided with a protective sheet metal cabinet.

2.3 HOT WATER BOILERS

2.3.1 Water Tube Boilers

2.3.1.1 In addition to the requirements of BS 1113, Boilers—General and Water Tube (Steam) boilers, the following shall apply:

a) Arrangements shall be made for positive water mixing to be induced within the boiler.

b) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the value(s) indicated.

2.3.2 Steel Shell 3-Pass Economic Boilers

2.3.2.1 In addition to the requirements of BS 855 or BS 2790 as indicated the following shall apply:

a) The design shall incorporate furnace observation port and tube attachment arrangements as for steam boilers (2.2.2.1).

b) Arrangement shall be made for positive water mixing to be induced within the boiler.

c) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the value(s) indicated.

2.3.3 Steel Shell Reverse-Flame Boilers

2.3.3.1 In addition to the requirements of BS 855 or BS 2790 as indicated the following shall apply:

a) The design shall incorporate furnace observation port and tube attachment arrangements as for steam boilers.

b) Arrangement shall be made for positive water mixing to be induced within the boiler.

c) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the value(s) indicated.

2.3.4 Continuous-Coil Hot Water Boilers

2.3.4.1 In addition to the requirements of BS 1113 as indicated the following shall apply:

a) The overall boiler heat transfer rate based on the fuel input (GCV) and 80% efficiency shall not exceed 70kW/m^2 of heating surface.

b) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the values indicated.

2.3.5 Electrode Boilers

2.3.5.1 In addition to the requirements of BS 1894, the following shall apply:

a) The boiler shell shall be of welded steel construction.

b) The boiler shall be capable of delivering its rated output when operated with water of specific resistance not less than 500 ohm cm at 65°C, under normal operating pressure and with an average water temperature difference (between inlet and outlet) of $65K \pm 5K$.

c) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the value(s) indicated.

2.3.6 Waste Heat Boilers

2.3.6.1 In addition to the requirements of BS 855, BS 1113 or BS 2790, as indicated, the following shall apply:

a) The boiler shall be matched to the requirements of the installations producing the waste gas.

b) Arrangements shall be made for positive water mixing to be induced within the boiler.

c) Water flow resistance(s) between boiler(s) flow and return connections shall not exceed the value(s) indicated.

d) The boiler shall be capable of withstanding the passage of the hot waste gas when drained of water as indicated.

2.3.7 Cast-iron Sectional Boilers

2.3.7.1 In addition to the requirements of BS 779 the following shall apply:

a) Boilers may be supplied factory assembled or in sections complete with manufacturer's instructions and all materials required for site assembly. The Contractor shall comply with the manufacturer's handling, erection and installation instructions.

b) Boilers shall be installed on purpose-made stands or plates which ensure that irregularities in the base do not interfere with the correct mating of the sections.

c) Facilities shall be provided for cleaning flueways. Access doors shall be designed for simple removal and replacement and shall close with a gas-tight seal. Hinged doors shall be provided with stops where necessary to prevent damage to the insulation and casing.

d) Arrangements shall be made for positive water mixing to be induced within the boiler.

e) A protective casing and insulating jacket shall be provided.

2.3.8 Steel 'Box-Type' Boilers

2.3.8.1 In addition to the requirements of BS 855 the following shall apply:

a) Boilers shall be of welded steel construction.

b) Facilities shall be provided for cleaning flueways. Access doors shall be designed for simple removal and replacement and shall close with a gas-tight seal. Hinged doors shall be provided with stops where necessary to prevent damage to the insulation and casing.

c) Arrangements shall be made for positive water mixing to be induced within the boiler.

d) A protective casing and insulating jacket shall be provided.

2.3.9 Modular Boilers of Low Water Content

2.3.9.1 In addition to the requirements of the relevant BS, the following shall apply:

a) The modules shall be identical and shall consist of cast iron sections or finned copper tubes expanded into cast iron or mild steel headers.

b) The modules shall be connected in parallel so that water from the common return header flows through the modules to the common flow header.

c) Boilers shall be designed to be fired by natural gas or LPG.

d) Boiler casings shall be insulated and provided with condensate drains.

e) The boiler flow header shall have provision for connecting a safety valve, pressure gauge, open vent, thermometer and a flow sensor as indicated.

2.4 DOMESTIC HOT WATER HEATERS

2.4.1 Electrical Resistance Heaters

2.4.1.1 In addition to the requirements of the relevant BS, the following shall apply:

a) The heater shell shall be of welded steel construction to BS 5500.

b) The heating elements shall be of the heavy duty copper sheathed wire type and shall be withdrawable.

c) The heater shall be insulated and provided with a protective sheet metal cabinet.

2.4.2 Oil or Gas-Fired Water Heaters

2.4.2.1 In addition to the requirements of the relevant BS, the following shall apply:

a) The heater shall be of all-welded steel construction or may be constructed of welded modules bolted together.

b) The shell interior and heat exchange surfaces shall be coated with a scale and corrosion resisting substance or shall be manufactured of a corrosion resisting material.

c) The burners shall be matched to the individual flues and shall be fired by Class D oil to BS 2869: Part 2, natural gas or LPG.

d) The heat exchangers shall flex when heated or have other approved positive provision to control scale formation.

e) A protective casing and insulating jacket shall be provided.

2.5 CONDENSING BOILERS

2.5.1 Unless otherwise indicated condensing boilers shall be as fully modulating gas-fired boilers with an additional heat exchanger fitted in the flue gas outlet from the main heat transfer section, and arranged so that the boiler return temperature shall be low enough to promote flue gas condensation.

2.5.2 The condensing section heat exchanger shall be of material indicated. Where it is necessary to use corrosion inhibiters these shall be as recommended by the boiler manufacturer.

2.5.3 Flue gas discharge shall be fan-assisted. Flues and chimneys shall be resistant to corrosion and be compatible with the boiler manufacturer's requirements. Spigot joints shall be upwardfacing and be sealed.

2.5.4 Flue branches shall be graded 3% minimum. Connections between boilers and chimneys shall be installed to a continuous rise.

2.5.5 The condensing section shall have a trapped condensate outlet. Connections from this outlet and from a trapped outlet at the chimney base shall be extended in polypropylene piping to the nearest suitable drain at a gradient of 3% minimum.

2.6 BOILERS EQUIPMENT

2.6.1 General

2.6.1.1 The Contractor shall be responsible for ensuring that the boiler manufacturer has approved the firing equipment offered to match the boilers they are intended to fire, in order to ensure completely satisfactory service. Evidence of proved compatibility shall be given, when requested by the PM.

2.6.1.2 Boilers shall be purpose-designed for firing by one of the following methods as indicated:

a) oil fuel with automatic burner;

b) solid fuel with mechanical, fixed grate or magazine type stoker;

c) gas with automatic burner, either forced air or atmospheric;

d) dual or multi-fuel firing (solid fuel/oil/gas).

2.6.1.3 All plant and equipment shall be selected to operate with noise levels that do not exceed those indicated.

2.6.2 Steam Boilers

2.6.2.1 Equipment of steam boilers shall comply with BS 759 and shall include the following for each boiler. The position of these shall be in accordance with manufacturer's standard arrangements.

a) Two safety valves, to BS 6759, mounted either singly or as a pair on a common body.

b) Lockable stop valve(s) as close as possible to the boiler (see Clause 2.1.7).

c) Steam pressure gauge.

d) Two independent water level gauges directly connected to the boiler shell (except boilers of less than 145kg/hour capacity for which one water level gauge is acceptable).

e) External feed water control, high and low water level control and alarms, and an independent overriding low water level control with its alarm; each fitted with sequencing blow-down valves and lockable steam isolating valves. With the PM's prior approval, direct mounted internal controls incorporating a testing device may be fitted on boilers up to 2250kg/h capacity if this is the boiler manufacturer's standard arrangement.

f) Lockable feed stop-and-check valve.

g) Manual blow-down valve (handle only removable when valve is closed) with a single handle for a range of boilers, or automatic blow-down valve or continuous blow-down valve with heat recovery, (as for 'Steam Boiler Blowdown').

h) Means for attaching a test pressure gauge.

j) Marked on the boiler, or on a plate attached to it, in a visible, legible and indelible form:

the manufacturer's name;

a serial number to identify the boiler;

the date of manufacture of the boiler;

the standard to which the boiler was built;

the maximum design pressure of the boiler;

the minimum design pressure of the boiler if it is other than atmospheric;

the design temperature.

k) A plate bearing a distinct and easily visible local number as agreed with the PM where two or more boilers are provided.

2.6.3 Hot Water Boilers

2.6.3.1 Equipment of boilers for water systems shall comply with BS 759, BS 855 and BS 779, as applicable, and shall include the following for each boiler. The positions of these shall be in accordance with manufacturer's standard arrangements.

a) One or two safety and gate/parallel-slide valves as required by the relevant BS.

b) Open vent pipe on LTHW systems when these are open to atmosphere.

c) Pressure gauge.

d) Thermometer.

e) Emptying cock(s) or drain valve(s) to be operated by removable key.

f) Marked on the boiler, or on a plate attached to it, in a visible, legible and indelible form:

the manufacturer's name;

a serial number to identify the boiler;

the date of manufacture of the boiler;

the standard to which the boiler was built;

the maximum design pressure of the boiler;

the minimum design pressure of the boiler if it is other than atmospheric;

the design temperature.

g) A plate bearing a distinct and easily visible local number as agreed with the PM where two or more boilers are provided.

2.6.3.2 On installations of two or more LTHW boilers, open to atmosphere, the open vent pipe from each boiler may be connected into a common vent pipe through a three-way cock so arranged that in no circumstances can any boiler be isolated simultaneously from the open vent pipe and from the free outlet.

2.7 INSTALLATIONS

2.7.1 Solid Fuel Installations

2.7.1.1 Solid fuel and ash handling and soot blower systems shall be provided as indicated.

2.7.2 Oil Fired Installations

General

2.7.2.1 Oil-fired installations shall comply with BS 799 Parts 3, 4 and 5 and BS 5410 Part 2 unless otherwise indicated.

2.7.2.2 Plant shall be designed and installed to operate in such a way that no smell of oil penetrates buildings or parts of buildings within the vicinity of the boiler house and oil store.

2.7.2.3 Oil-burning installations in excess of 6MW (9600kg/hour) capacity and utilising Class F oil to BS 2869: Part 2 shall also be able to burn Class G oil.

Oil Storage Tanks

2.7.2.4 Oil storage tanks, including fittings shall be constructed to BS 799 Part 5 and shall be of the type and size as indicated.

2.7.2.5 Oil storage tanks shall be inspected, tested and certified by the relevant Competent Person (Section 12).

2.7.2.6 Unless otherwise indicated the exteriors of exposed, above-ground oil tanks shall be painted including thorough cleaning of the steel in accordance with the recommendations of all relevant parts of BS 7079, rust inhibitor, primer and 2 coats of oil resistant finish paint and buried tanks shall have 3mm bitumen coating in lieu of the finish paint. The interior of all tanks shall be wire brushed but not painted except for zinc phosphate alkyd corrosion protection of the underside of the crown of large vertical cylindrical tanks. External insulation shall be as indicated.

Tanks shall be located in an oil-tight bund with impervious sump, impervious base, no damp course and no drainage outlet, and sized to accept 110% of the volume of the tank.

2.7.2.7 Buried tanks shall be suitably anchored. Prior to installation external surfaces shall be thoroughly cleaned of rust, scale, grease and oil and painted a 3mm coat of filled bitumen. The installation of the tank shall be to clause 45.2.3 of BS 5410 Part 2.

Oil Tank Fittings and Feed Line

2.7.2.8 Tank installations shall be fitted or provided with the following:

a) A non-corrodible plate approximately 250 x 100mm at each filling point clearly and indelibly inscribed 'Boiler Fuel' and bearing the BS 2869: Part 2 class of oil to be supplied to the system, together with a permanent identifying plate to clause 5.5 of BS 799 : Part 5.

b) A dip stick or tape with calibrated chart for each tank, as indicated. The units employed shall be litres for tanks up to 1000 litres, and m^3 above 1000 litres.

c) A contents gauge of the continuous indication type with remote reading. The gauge shall be of a weatherproof pattern or located in a weatherproof housing. The gauge shall be operated by hydrostatically, electrically, by magnetic float or other approved means. The capillary transmitter of hydrostatic gauges shall be replaceable. The gauge shall be marked 'FULL' and 'EMPTY' to indicate the limits of usable oil in the tank ie. to correspond with high-level alarm and fuel outlet levels respectively. Gauges on tanks shall be calibrated in litres for tanks up to 1000 litres capacity and in m^3 for capacities above.
(Note: Battery-powered devices are not permitted).

d) A weatherproof audible warning bell or other approved device, arranged for muting and automatic reset to give clear warning at the filling point when the tank has been filled to 90% capacity. A plate similar to that for fuel identification shall be fitted near the warning device to indicate its purpose.
(Note: Battery-operated devices are not permitted).

e) An outflow heater supplemented by a de-sludging coil for both Class F and G oils.

f) An oil flow temperature indicator for both Class F and G oils.

g) A tank immersion heater for Class D oil, where indicated.

2.7.2.9 The oil feed line(s) shall be provided with the following:

a) First stage filters of the dual type with isolating valves and drain cock.

b) A bulk oil flow meter where the total rated oil consumption exceeds 25 litre/hour.

c) A valved by-pass for insertion of a test meter, adjacent to each burner where the boiler rating exceeds 150kW (240 kg/h steam output).

d) A self regulating or thermostatically controlled moistureproof type of electric trace heating on the oil feed lines for Classes F and G oil and for Class D oil where indicated. The tracer shall be rated to give not less than 40 watt per metre length of feed line and shall keep the oil(s) at or above the indicated temperatures. The tracer and pipe together shall be thermally insulated and weatherproofed in accordance with Section 10.

e) Oil circulating pumps in accordance with Section 3 where indicated.

f) A fire valve with fusible link or other temperature operated quick release device arranged as for the fire valve system specified in Clause 2.7.2.3.3.

g) A shut-off valve, electrically or mechanically operated by a float mechanism contained in a mild steel open top tank of not more than 25 litres capacity. The tank shall be contained within a sump as small as is practicable to house it, located at the lowest point in the floor of the boiler house but separated from any pit connected to the main drainage system. Floor ducts, etc, as necessary shall be provided to ensure that any oil leakage readily drains into the floor tank. When electrically operated, the valve shall shut on the breaking of the circuit. Unless a fault condition exists, it shall open automatically, without manual resetting, upon the restoration of electrical supply following an interruption. The shut-off valve may be additional to the fire valve (as above) or, where the fire valve would otherwise be of the electrically maintained type and the sump float is connected electrically to a shut-off valve, the thermal fuses for the fire valve and the sump float switch may be wired in series to a single electrically maintained valve.

2.7.2.10 The fire valve system shall be arranged as follows:

a) Each fusible link or other temperature operated quick release device controlling the fire valve in the oil-feed line shall incorporate a switch arranged to break the control circuits and shut down the oil handling and burning plant only when the fusible element is broken, or the quick-release device is operated (ie the system water circulating pumps, etc, must remain in operation). Electrical terminals suitable for 230 volts 50 Hz shall be incorporated in the switch from which connections can be taken, under separate contract.

b) Each fire valve system shall be provided with a manual quick-release device or manually reset pushbutton to close the fire valve in an emergency and for testing purposes. The device or switch shall be positioned close to the main boiler room exit and identified by a white plastic plate not less than 100mm long x 75mm high, with an inscription engraved in 10mm red lettering to suit the action required, such as: FIRE. IN CASE OF FIRE STRIKE KNOB.

2.7.2.11 Wires for mechanically operated fire valve release systems shall be of stainless steel. Pulleys shall be free-running with a minimum diameter of 50mm and shall retain the wires without binding.

2.7.2.12 Valves and cocks of any tank not within a building shall be lockable.

Oil Heating

2.7.2.13 Tank and system heaters shall be electric, water/electric or steam/electric, as indicated, and shall be thermostatically controlled.

2.7.2.14 Condensate from steam heated coils is to be free draining and shall discharge via a steam trap to waste.

2.7.2.15 Hot water supplies for heating coils shall be provided from the secondary circuit of a non-storage calorifier.

2.7.2.16 Design temperatures and construction shall be in accordance with BS 799 Part 5 and BS 5410 Part 2.

2.7.2.17 Each outflow heater shall be bolted to a flanged stool in the tank and shall incorporate:

a) An outflow temperature indicator.

b) A weatherproof terminal box enclosing all electrical connections.

2.7.2.18 De-sludging coils shall extend one third of the distance across the tank. They shall be mounted to enter and exit from the tank beneath the level of the outflow and adjacent to the drain valve; and shall be sized to permit free flow of otherwise cold oil across the tank to the outflow. Control shall be by hand operated shut-off valve.

Oil Burners

2.7.2.19 Oil burners shall be of the fully automatic type incorporating oil pressure gauges and, if required, oil pre-heaters and temperature indicators. Ignition shall be electric or gas/electric, employing natural gas or LPG. Gas systems shall include all necessary pipework, valves and controls for safe connection to natural gas mains, LPG mains, or to LPG bottles supplied by contractors under other arrangements.

2.7.2.20 Burners, oil pipes and cables shall be installed so as to provide ample facilities for inspection and maintenance. All adjustments shall be provided with pre-setting arrangements so that they are not altered by normal cleaning and day-to-day maintenance.

2.7.2.21 Except where small burners are mounted directly on the boiler front, and means of easy access to the combustion head components is provided, burner units shall be mounted in such a way that the whole unit can be swung clear or moved away from the boiler for cleaning. Positive location of the burner in its operating position shall be provided. Flexible oil and electrical connections shall also be provided. The burner mechanism shall be incapable of firing unless the burner is secured in the correct operating position.

Foam Inlets

2.7.2.22 Foam inlets shall be provided as indicated and installed in accordance with the requirements of Section 4. A plate similar to that for fuel identification shall be fitted near each purpose-made foam inlet box to indicate the areas served. Additional or alternative fire fighting arrangements shall be provided as indicated.

2.7.3 Gas Fired Installations

2.7.3.1 Gas-fired boilers shall be capable of the duty indicated when burning gas of the calorific value or gas group number of the local gas supply or particular LPG installation. Gas burners shall be atmospheric or

forced air type as indicated and shall comply with BS 5978 where appropriate. Additionally installations using forced air gas burners shall comply with BS 5885 and BGC Code of Practice IM/30 as appropriate. For installations where the total rated output exceeds 200kW (320kg/hour steam output) and the boiler house service pipe is not equipped with an individual primary gas meter, a secondary meter shall be fitted to the installation pipe within the boiler house. Where the individual boiler rating(s) exceed(s) 150kW (240kg/hour steam output) provision shall be made for the insertion of a test meter adjacent to each burner. Boilers shall comply with the UK Boiler Efficiency Regulations and carry the CE mark to indicate compliance. The CE star rating system indicator shall also be shown.

2.7.3.2 When the contract includes a gas supply into a building an external isolating gas cock shall be located in an accessible position to be agreed with the PM. A further isolating gas cock shall be positioned immediately after the gas main enters the boiler room.

2.7.3.3 Gas pressure boosters, as indicated, shall be duplicated with isolating valves on the gas main. Alternatively, single boosters, with isolating valves, shall be installed in the gas supply to individual boilers. The gas pressure boosters shall be designed for the easy replacement of gas seals, and shall be installed in accordance with IGE Utilization Procedures IGE/UP/2.

2.7.4 Dual-Fuel and Multi-Fuel Installations

2.7.4.1 Boilers intended for dual-fuel firing shall be designed for natural gas or LPG firing and the burners shall comply with BS 5885 and BGC Code of Practice IM/30. The primary fuel shall be natural gas or LPG with oil as the stand-by.

2.7.4.2 Boilers intended for multi-fuel firing shall be capable of conversion to natural gas. LPG or oil firing with a minimum of alteration. Where indicated boilers specified, gas and/or oil-fired, shall have proven capability as fully automatic coal-fired units with the output ratings as required in this Contract.

2.8 COMBUSTION CONTROLS

2.8.1 General

2.8.1.1 All controllers shall be contained within a casing as Section Eight—Automatic Controls, Controllers, Cubicles and Panels—suitable for wall, frame or panel mounting as indicated, or shall be part of a burner assembly with provision for external wiring connections, switches and indicator lights.

2.8.1.2 All controllers shall be protected against overcurrent conditions by means of integral fuses, or miniature circuit breakers.

2.8.1.3 Unless otherwise indicated boiler firing controllers shall be fitted with an electrically or mechanically activated reset device to return the controller automatically to the start position after an interruption of the power supply, and return it to normal when power is restored.

2.8.1.4 All controllers shall be designed to 'fail-safe' so that the failure of any component liable to give rise to a potentially hazardous condition, shall prevent the operation of the complete unit and the boiler shall be held in, or returned to, a safe shut-down condition.

2.8.1.5 Unless otherwise indicated control cubicles and panels shall conform to the provisions of Section Eight.

2.8.2 Oil Burners

2.8.2.1 The burners shall be controlled by one of the following methods as indicated:

a) On/off control.

b) High/low/off control. The burner shall be arranged to start on low flame and the time spent at low flame before changing to high flame shall be between 10 and 60 seconds. A facility to lock the burner in the low flame position shall be included. The nominal turn down ratio shall be 2:1, or as recommended by the boiler manufacturer for the particular operating conditions.

c) Fully modulating control. The burner shall be arranged to start on low flame. The turn down ratio shall be as recommended by the boiler manufacturer and as appropriate for the burner type.

2.8.2.2 Burners on steam boilers shall be controlled by a pressure sensing element located in the boiler steam space. It shall bring on/off burners in and out of operation, respectively at not more than 5% below and above the element set point pressure. The modulation of high/low/off and fully modulating burners shall also be accomplished within that pressure range. The set point pressure shall be adjustable over the range indicated.

2.8.2.3 Burners on hot water boilers shall be controlled by a temperature sensing element located in the boiler unit in a position where the water temperature is representative of the boiler flow temperature. It shall bring on/off burners in and out of operation respectively at not more than 5% below and above the element set point temperature. The modulation of high/low/off and fully modulating burners shall also be accomplished within that temperature range. The set point temperature shall be adjustable over the range indicated.

2.8.3 Gas Burners

2.8.3.1 Gas burner controls shall generally comply with the requirements for oil burner control as indicated.

2.8.3.2 The location of pressure/temperature sensing elements in the boiler shall be as for oil burners including sensing element ranges and differentials.

2.8.3.3 Natural and forced air gas burners shall have on/off, high/low/off or fully modulating control generally, as provided for oil burners in Clause 2.8.2.1, or as indicated.

2.8.4 Solid Fuel Installations

2.8.4.1 The location of pressure/temperature sensing elements in the boiler shall be as for oil burners including sensing element ranges and differentials.

2.8.4.2 Magazine boilers shall be controlled by the on/off operation of the forced draught fan. Automatic stokers shall be controlled by the on/off, high/low/off or fully modulating operation of the forced/induced draught fan and fuel feed mechanisms or grate, as indicated.

2.8.5 Dual and Multi-Fuel Burners

2.8.5.1 Dual and multi-fuel burner controls shall generally comply with the relevant clauses for oil burners, gas burners and for solid fuel installations, as relevant, and as indicated.

2.8.6 Electric Boilers

2.8.6.1 Steam and hot water boilers heated by electrical immersion heaters shall be arranged for on/off, high/low/off or Multi-step Control, as indicated.

2.8.6.2 Electrode boilers in which steam is produced or water is heated by the passage of an alternating electrical current between electrodes sited within the boiler shell shall be arranged for on/off control with hand regulation or for the fully modulating control of the exposure of the electrodes to the boiler water. The controls shall comply with BS 1894.

2.8.6.3 The controls and sensing elements shall generally comply with the requirements for oil burner controls as indicated.

2.8.7 Multi-Boiler Installations

2.8.7.1 Multi-boiler installations shall be arranged for sequence control unless otherwise indicated. For the purpose of this Specification, sequence control shall mean the automatic and progressive starting up of the individual boilers, in response to system demand in a pre-selected order, and the progressive shutting down, on decreasing system demand, in the reverse order. Facilities shall be provided for manually changing the order of operation and for taking individual boilers out of the operating sequence. Unless otherwise indicated, boiler control shall be proportional to the deviation from the set point of temperature or pressure, as applicable. The sensing element of the Sequence Controller shall be located in the common steam header in the case of steam boilers. In the case of hot water boilers it shall be located in the common flow main except that where provision is made for constant water mass flow in the boiler(s) circuit, it shall be located in the common return main, as indicated. The rate of response of the Sequence Controller shall match the characteristics of the steam or hot water system to which it is fitted. A timer, adjustable between 0 and 15 minutes, shall be incorporated and set to reduce unnecessary cycling. Upon restoration of the power supply after any break the Sequence Controller shall reset to the OFF position and then restart automatic control in the set sequence.

2.8.7.2 Each steam boiler in a multi-boiler installation controlled as in Clause 2.8.7.1 shall be equipped with a banking pressurestat which shall hold the available duty boilers at a reduced pressure. Individual boilers shall be governed by a control (normally its own pressurestat) which will reduce the burner firing rate if the boiler pressure exceeds the set pressure of the master controller in order to prevent premature operation of the high limit pressurestat associated with that boiler.

2.8.7.3 Each steam boiler in a multi-boiler installation controlled as in Clause 2.8.7.1 shall be equipped with a non-return valve to prevent the admission of steam from the common header.

2.8.7.4 Each hot water boiler in a multi-boiler installation controlled as in Clause 2.8.7.1 shall be provided with a motorised butterfly type valve, the full size of the pipework, in the return water connection. The valve shall be electrically interlocked with the burner and shall automatically open fully prior to the commencement of the burner start-up sequence. Operation of the burner shall be prevented unless the valve is fully open. When the burner shuts down, the valve shall shut after completion of the burner post-purge sequence and after a further short time period to suit the system. When nominally shut, the valve shall continue to allow some water circulation through the boiler as indicated. The valve on the first boiler selected in the operating sequence shall remain fully open at all times. Additionally, where constant water flow rate is required, the boiler(s) flow and return headers may be connected by shunt pipes under the control of motorised valves.

2.8.7.5 Modular boilers, consisting of not more than two modules, shall be arranged for sequence control utilising the individual module burner control thermostats. Units consisting of more than two modules shall be supplied with a purpose-made sequence controller and sensor element for installation in the main flow or return piping. Where the fitting of a motorised butterfly type valve (Clause 2.8.7.4) is inappropriate, groups of modules shall be provided with a motorised three-way valve arranged to operate in a diverting mode.

2.9 SAFETY CONTROLS

2.9.1 Steam Boiler Systems

2.9.1.1 All automatically controlled steam boilers shall be fitted with the safety controls required by HM Health and Safety Executive Guidance Note PM5, which effectively shut off the supply of fuel to the burners of oil or gas fired boilers, or the air and fuel supply to solid fuel fired boilers in the following circumstances:

(Note: * indicates reference to 2.9.3.2)

a) *Flame and/or pilot-flame failure.

b) *Failure to ignite the fuel within a preset time—on oil or gas fired boilers.

c) When maximum operating pressure is reached. This pressure shall be at least 70kN/m^2 below the pressure at which safety valves are set. See Clause 2.8.2.2.

d) *High pressure. This shall be an independent overriding control set to operate at a pressure at least 35kN/m^2 above maximum operating pressure, and at least the same amount below the pressure at which the safety valves are set.

e) First Low Water Level. When water level falls to a preset level below normal working level.

f) *Second Low Water Level. This shall be an independent overriding control set to operate at minimum permitted water level.

g) Failure of draught fans and/or automatic flue dampers.

h) When water reaches a point still visible in the gauge glass above which there is a risk of carry-over of water into the distribution system.

j) Electrical fault in any control or associated equipment; ie the firing and water level control systems shall be fail-safe.

k) *Failure of electrical supply to any part of the firing and/or water level control systems.

2.9.2 Hot Water Boiler Systems

2.9.2.1 These are defined as follows:

Category A : Static head systems open to atmosphere.

Category B : Closed pressurised systems with separate gas cushioned pressurising vessels and provision for make-up water.

Category C : Sealed pressurised systems with separate diaphragm or bladder type pressurising vessels and provision for make-up water.

Category D : Continuously pumped pressurised systems with provision for make-up water.

2.9.2.2 Hot water boilers in systems pressurised by steam are classified as steam boilers and shall be so equipped (Section 2.9.1).

2.9.2.3 All automatically controlled hot water boilers shall be fitted with the safety controls required by PM5, which effectively shut off the supply of fuel to

the burners of oil or gas fired boilers, or the air and fuel supply to solid fuel fired boilers in the following circumstances:

(Note: * indicates reference to 2.9.3.2)

a) Those circumstances specified in Clauses 2.9.1.1(a), (b), (g), (j) and (k).

b) When the water at or near the boiler water outlet reaches a temperature at least 17K below the saturation temperature corresponding to the lowest static pressure in the system. See Clause 2.8.2.3.

c) *When the water at or near the boiler water outlet reaches *a* temperature at least 6K below the saturation temperature corresponding to the lowest static pressure in the system for oil and gas fired boilers, and at least 10K below for solid fuel fired boilers, with a tolerance of ± 3K. This shall be an independent overriding control.

d) *When the pressure in a Category B, C or D system falls below normal operating pressure. The set-point pressure shall be chosen to ensure that water cannot boil anywhere in the system whilst working temperature is maintained.

e) When the water level in a Category B system falls to a preset point below normal working level.

f) When the pressure in a Category C system reaches *a* point above normal operating pressure. This set pressure shall be at least 35kN/m^2 below safety valve setting, which must in turn be below the design pressure of the weakest part of the system.

g) *When the water level in a Category B system falls to a preset level below that in e). This shall be an independent overriding control.

h) When the water level in the spill-tank of a Category D system falls to a level selected to ensure that pumps do not cavitate.

2.9.2.4 Where indicated the controls in Clause 2.9.2.3 shall also stop boiler and/or distribution circulating pumps.

2.9.3 General Requirements

2.9.3.1 Safety control components shall be fitted to boilers, burners and/or pressurisation equipment at points where there can be no doubt as to their efficacy. The components shall be connected together into a single homogenous control system.

2.9.3.2 The circumstances marked * in Clauses 2.9.1.1 and 2.9.2.3 shall cause the firing controls to go to the lock-out condition. Lock-out control devices shall be protected against unauthorised interference, and they shall require to be reset by hand.

2.9.3.3 Unless otherwise indicated controls, other than lock-out controls, shall recycle and restart—if and when the relevant operational condition is restored to normal.

2.9.3.4 Where permitted by the relevant BS, burner control systems shall be arranged to recycle and attempt one automatic start following a flame, pilot flame, or ignition failure. If this one attempt fails the control system shall proceed to the lock-out condition.

2.9.3.5 Visual indication of fault conditions shall be provided as indicated in Section 2.11.

2.10 PROTECTION CONTROLS

2.10.1 General

2.10.1.1 Hot water boiler system controls shall ensure that firing cannot occur in the absence of water circulation through the relevant boiler(s).

2.10.2 Preheating

2.10.2.1 Hot water boilers having ratings exceeding 150k W shall be provided with one of the following methods of preheat control, as indicated, to ensure boiler water temperature does not fall below 60°C:

a) Automatic diversion of some or all of the water leaving the boiler into the boiler return.

b) Automatic overriding control of final distribution circuit controls to full bypass.

2.10.3 Overheating

2.10.3.1 Hot water boilers programmed by timing systems shall be protected from overheating and consequent operation of high temperature lock-out controls by one of the following methods as indicated:

a) Continued pumped circulation for a time after firing has stopped. The time period shall be adjustable up to 60 minutes and it shall be set to suit the system's characteristics.

b) Continued pumped circulation after firing has stopped until water temperature at the boiler exit is safely below the lock-out setting.

2.11 INDICATOR LIGHTS AND ALARMS

2.11.1 Steam boiler plant shall be provided with the following state or fault lights as indicated:

a) Equipment (eg burners, pumps etc) on.

b) Equipment running.

c) Equipment lock-out.

d) Flame or pilot-flame failure.

e) Ignition failure.

f) Fan failure.

g) Flue damper failure.

h) Control equipment failure.

j) First low water level alarm.

k) Second low water level lock-out.

1) High water level.

m) High pressure lock-out.

n) Others as indicated.

2.11.2 Hot water boiler plant shall be provided with the following state or fault lights as indicated:

a) As Clause 2.11.1(a) to (h).

b) High temperature lock-out.

c) High pressure.

d) Low pressure.

e) Low pressure lock-out.

f) Low water level alarm.

g) Low water level lock-out.

h) Low level in spill tank.

j) Others as indicated.

2.11.3 The fault conditions as described in Clauses 2.11.1 and 2.11.2 shall give rise to unmistakable audible and visual alarms at the boiler plant room(s), which are clearly distinguishable against the ambient noise conditions. The types and precise locations of sounders and beacons shall be as indicated.

2.11.4 Remote audible and/or visual alarms shall be provided at the locations as indicated. They shall show the technical information and the actions to be taken by remote station personnel in the event of alarm as indicated. Failure of communication links between the boiler plant and remote stations shall cause the alarms at both ends to operate.

2.11.5 Power and standby power arrangements for the boiler plant and the remote alarm panels shall be as indicated.

2.11.6 'Accept Alarm' buttons on the local and remote alarm panels shall cause the audible and visual alarms to stop and remain insensitive to the faults which triggered them. The alarm system shall otherwise remain sensitive and sound whenever a new fault occurs.

2.12 CHIMNEYS, FLUES AND FLUE DUCTS

2.12.1 Chimneys shall be designed, manufactured and erected in accordance with BS 4076, BS 5854, or other standard as indicated. They shall have design life corrosion allowances as indicated. Proprietary chimney systems conforming to BS 4543 may be accepted as indicated. Chimneys shall be provided with liners constructed of steel or proprietary products as indicated.

2.12.2 Flues shall be constructed of carbon steel or proprietary products incorporating easy bends, insulated as necessary to minimise condensation of flue gases. Jointing materials shall be heat-resisting.

Gas fired boilers shall be provided with carbon steel, single wall stainless-steel or aluminium twin-wall proprietary flues as indicated.

Boiler flue ducts shall have insulated supports and shall be provided with cleaning doors.Where a flue duct enters a brick or concrete chimney or passes through a wall the Contractor shall provide a metal sleeve for 'building-in'. The space between the sleeve and the flue duct shall be packed with heat resistant material. Flue ducts shall have an upward rake and shall finish flush with the inside face of the chimney flue.

Where a flue duct is required to be connected either to a self supporting steel chimney, or to a proprietary type of flexible chimney lining, the manner of connection shall be as indicated.

2.12.3 Diluted flue systems for very low sulphur (VLS) fuels shall be in accordance with the recommendations of 'Chimney Heights—Third Edition of the 1956 Clean Air Act Memorandum'. Both openings for a diluted flue shall be on the same wall face.

2.13 DAMPERS

2.13.1 Where indicated, boilers fired by oil and/or gas, other than where atmospheric burners are fitted, shall be fitted with a combustion air inlet sealing damper or gas tight/flue sealing damper. The flue sealing damper shall be of the open/shut or constant draught modulating type as indicated. Where more than one solid fuel fired boiler is connected to a common chimney flue system, each boiler shall be fitted with a hand-operated flue sealing damper, interlocked with the stoker mechanism, as indicated.

2.13.2 For the purpose of this Specification, gas-tight means that any inefficiency in the damper seating when closed shall not permit the leakage rate to exceed that of a circular orifice equal to 0.05% of the flue duct cross-sectional area. The PM reserves the right to have the gas-tightness demonstrated before acceptance. The damper casing shall be fitted with a removable cover plate so that the damper mechanism can be examined in situ. Each damper shall be electrically interlocked with the firing controls to open and close automatically when the boiler is cycling, and in conjunction with the burner purge sequence. When the damper is in the closed position the burner controls shall be inoperative. Dampers fitted on flue gas outlets shall generally comply with requirements of BGC publication IM/19 (Automatic flue dampers for use with gas fired space heating and water heating appliances) and shall be of the edge-hung type, and fail safe to open by being free to act as an explosion relief to the chimney. When gas-tight dampers are installed in association with gas fired or dual fuel burners, the requirements of BS 5885 or BS 5978 shall be followed as appropriate.

2.14 HOT WATER SYSTEM PRESSURISATION

2.14.1 General

2.14.1.1 Pressurisation shall be effected by the following methods as indicated:

a) Nitrogen gas pressurisation systems.

b) Sealed diaphragm vessel systems.

c) Constant running pump systems where permitted.

d) Open vented systems pressurised by static head.

2.14.1.2 Pressurising systems and their controls shall be arranged to fail safe.

2.14.1.3 Pressurising equipment shall be of packaged construction with provision for simple connection to the boiler plant and to the boiler plant control systems. Where practical it shall be mounted on a common base frame.

2.14.1.4 Pressurising equipment controls shall be arranged with lockable isolating valves and drain valves which safely enable control functions to be tested whilst the boiler plant remains in service.

2.14.1.5 Feed and/or pressurising pumps shall be sized having regard for the expected system contraction rate.

2.14.1.6 Provisions shall be made for quick-filling the heating systems in parallel with the make-up water systems provided for normal service.

2.14.1.7 The appointed Inspection Body for pressure vessels shall be the company indicated in Section 12.

2.14.1.8 Joints and connections of the components of pressurising equipment shall comply with the requirements of Section 4.

2.14.1.9 Pressurising equipment shall be fitted with drain valves as necessary to enable complete drainage in isolation from the heating system.

2.14.2 Gas Pressurisation Systems

2.14.2.1 These shall control the water level and pressure in the heating systems by the following methods as indicated:

a) Containment of the entire expansion volume of the heating system within the pressure vessel.

b) Discharge of the expansion volume of the heating system to spill tank, but with no transfer between spill tank and expansion vessel between normal operating temperature limits.

c) As b) but including transfer between spill tank and expansion vessel during normal operations.

2.14.2.2 The equipment shall be provided as purpose-made sets comprising feedwater connections, spill tank(s), transfer pumps, expansion vessel(s), heating system connections and all necessary controls, safety devices, power, gas connections and automatic gas rejection controls.

2.14.2.3 Pressure vessels shall be constructed in accordance with BS 5500 Category 3. The pressurisation system manufacturer shall have responsibility for the design and manufacture of the complete pressurising systems. The design temperatures of the vessels shall be not less than the maximum temperatures of the relevant heating systems. The vessels shall be internally finished with a corrosion resistant coating. Manholes and hand holes shall be provided as agreed with the Inspection Body to facilitate Statutory Examinations.

2.14.2.4 Each pressure vessel shall have a spring safety valve with open discharge run visibly to waste.

2.14.2.5 Water level gauges showing high and low level shall be unbreakable. They shall be fitted with isolating valves.

2.14.2.6 The make-up water systems shall include a cumulative meter and shall be controlled to deliver water at rates consistent with recording accuracy.

2.14.2.7 Each pressurising system shall have duplicate transfer pumps with controls enabling manual selection of duty pump and auto-changeover in the event of duty pump failure. The standby pump shall start if the duty pump fails to maintain pressure. Each pump shall be provided with a strainer, a non-return valve, and isolating valves.

2.14.2.8 Each nitrogen system shall provide for connection and exchange of commercial nitrogen cylinders whilst the system is in service, and where indicated the temporary connection of a compressed air service. Provisions shall include lockable racks for an appropriate number of duty and reserve cylinders.

2.14.3 Sealed Diaphragm Vessel Systems

2.14.3.1 These shall not be used to pressurise HTHW systems.

2.14.3.2 The equipment shall be provided as purpose-made sets comprising feedwater connections, holding tank(s), pump(s), expansion vessel(s) with internal flexible diaphragm(s), heating system connections and all necessary controls, safety devices and power connections.

2.14.3.3 Expansion vessels operating up to 6 bar pressure shall be constructed in accordance with BS 4814 and shall have replaceable diaphragms. Unless otherwise indicated vessels shall be Grade 1.

2.14.3.4 The make-up water system shall include a cumulative meter and shall be controlled to deliver water at rates consistent with recording accuracy.

2.14.3.5 Each set shall have a pump or duplicate pumps as indicated. The duty pump shall be controlled by a pressure sensor set to ensure minimum static pressurisation of the heating system. Where duplicate pumps are required, duty, standby and changeover controls shall be as indicated in Clause **2.14.2.7.** Pumps shall be installed with strainers and isolating valves, and with non-return valves as appropriate.

2.14.4 Constant or Intermittent Running Pump Systems

2.14.4.1 The equipment shall be provided as purpose-made sets comprising feedwater connections, holding tanks, duplicate pumps, expansion vessel(s), connections to the heating systems and all necessary controls, safety devices and power connections.

2.14.4.2 A strainer, non-return valve and isolating valves shall be provided for each pump.

2.14.4.3 The connection to each system shall be through pipes and/or vessels having sufficient volume to contain the total quantity of water expanded from the heating system whilst any boiler is firing through its temperature control differential range.

2.14.4.4 Pressure vessels shall meet the requirements of Clause 2.14.2.3.

2.15 WATER TREATMENT

2.15.1 General

2.15.1.1 Provisions shall be made for the pre-treatment and chemical conditioning of the water supplies to the installations as indicated. These provisions shall comprise purpose-made assemblies of equipment obtained from specialist manufacturers, with all the components necessary to achieve the specified performance. The installations shall be arranged in neat and compact layouts allowing proper access for maintenance and simple operation without spillages.

2.15.1.2 Details of the source and character of the water supplies to the plant rooms, the water pressure at the points of supply, the specifications of the required water temperature, processes and throughput rates, and the chemicals to be used, are provided in the Contract Documents.

2.15.1.3 Proposals for water treatment installations, detail design and equipment selection shall be approved by the PM before orders are placed. The PM's adviser in respect to water treatment will be the MOD's specialist contractor for water treatment services for the particular location as indicated.

2.15.1.4 In general, provisions for steam installations shall meet with the recommendations of BS 2486.

2.15.1.5 In general, base-exchange water softening plant shall meet with the recommendations of BEWA Code of Practice 01.85.

2.15.1.6 Water pre-treatment plant to be directly connected to the water supplies shall be provided with check and anti-vacuum valves complying with BS 6282, and/or other means of protection from back-flow as required by the Water Company.

2.15.1.7 Feed water and/or make-up water systems shall be provided with by-pass arrangements, to enable the use of temporary plant for initial filling and subsequently in the event of failures. See also Clause 2.14.1.6.

2.15.1.8 Effluent from water treatment installations and steam boiler blow down systems shall be discharged into the drainage system with provisions for effluent treatment as indicated.

2.15.1.9 Water treatment installation components shall be constructed of inert materials or otherwise be suitably treated on all exposed surfaces with corrosion-resistant coatings.

2.15.1.10 A cumulative water meter calibrated in litres shall be provided on the water supply connection to each feed water and make-up water system. The metering system shall include delayed-action float valves or automatic valves as necessary to ensure meter accuracy.

When relevant and approved by the PM, the metering system components shall be supplied for others to install with the cold water service, but responsibility for both proper installation and commissioning shall remain part of this Contract.

2.15.1.11 Provisions for taking water test samples from HTHW and MTHW systems, and steam boilers shall be provided at the locations indicated. The provisions shall include at each location a connection to the heating system or steam boiler with lockable isolating valve, a sample cooler complying with BS 6068, Section 6.7, permanent connections for cooling water, and permanent connections to the drainage system. Connections to heating systems and steam boilers shall be made at points where blockages are unlikely, and pipe runs to sample coolers shall be as short as practical considerations permit.

2.15.1.12 Draw-off cocks for taking water test samples from LTHW systems shall be provided at the locations as indicated.

2.15.1.13 Water test sample containers approved by the PM shall be supplied as indicated.

2.15.1.14 Stores of the chemicals needed to operate water pre-treatment plant and to condition the initial fills, feed water, make-up water and system water shall be supplied and deposited at locations to be agreed with the PM. Unless otherwise indicated sufficient quantities of chemicals shall be supplied to enable the initial filling and any refilling in accordance with specification, commissioning, and operation at design consumption rates for 2 months.

2.15.2 Water Pre-Treatment Plant

2.15.2.1 Pre-treatment plant shall be provided and shall feed into the store tanks, hotwells, feed and expansion tanks or intermediate holding tanks to be provided in this Contract as indicated. Additional points of connection to these reservoirs shall be provided as indicated to enable treated water supply to other systems. The connections to the other systems will be provided by others.

2.15.2.2 For steam installations water pre-treatment shall comprise softening by base-exchange alone, softening by base-exchange preceded by de-alkalisation and de-gassing or by base exchange followed by reverse osmosis as indicated.

2.15.2.3 For HTHW and MTHW installations water pre-treatment shall comprise full de-mineralisation effected by twin-bed or cartridge de-ionization or by a combination of base-exchange and reverse osmosis, as indicated.

2.15.2.4 For LTHW systems with individual boiler capabilities exceeding 1MW, water pre-treatment shall comprise softening by base-exchange.

2.15.2.5 Pre-treatment plants shall be provided with controls for both manual and fully automatic operation. The control systems on each plant shall stop it safely and set off the plant room alarm in the event of water supply failure, power failure, failure to achieve specified quality, overfilling of the vessel being supplied and any other unsafe conditions identified by the equipment manufacturer.

2.15.2.6 Unless otherwise indicated water pre-treatment plant requiring regeneration shall be designed to achieve the specified throughput rate with regeneration about once every 24 hours. Regeneration shall be automatically controlled dependent upon volume throughput but with provision for manual override. Water meters shall be calibrated in litres and shall indicate cumulative total volume, regeneration set volume, and volume since last regeneration; see Clause 2.15.1.10.

2.15.3 Steam Boiler Blow-Down

2.15.3.1 Blow-down systems shall comply with Health and Safety Executive Guidance Note PM60, BS 806 and BS 759, and shall be certified by the Inspection Authority nominated in Section 12. The blow-down systems shall be manual, intermittent automatic, or continuous automatic as indicated.

2.15.3.2 Automatic blow-down valves shall comply with the requirements of Section 7.

2.15.3.3 Automatic blow-down systems shall be connected to boilers at points close to water surface level, and shall be controlled to operate only when their boilers are firing. They shall be set to achieve minimum blow-down consistent with ensuring boiler manufacturers' recommended maxima for Total Dissolved Solids are not exceeded.

2.15.3.4 Unless otherwise indicated or approved intermittent automatic blow-down rate shall not exceed 10% of boiler rating. Where continuous blow-down rate is intended to exceed 10% of boiler rating, heat recovery plant comprising flash steam recovery vessels, and make-up water pre-heaters shall be provided as indicated.

2.15.3.5 The disposal of discharge should conform to any Local Authority Regulations and, any case the water temperature should not exceed 110°F (43°C).

2.15.4 Chemical Conditioning Equipment For Steam Systems

2.15.4.1 Each installation shall have a chemical solution injection system comprising a valved connection from the water pre-treatment plant, a mixing tank with integral agitator, injector pumps, a dosing pot, and with sundry valves and connections as necessary.

2.15.4.2 Boiler internal feed water delivery and dispersal pipework designs shall prevent premature chemical reaction and blockages.

2.15.4.3 Mixing tanks shall be moulded heavy duty high density polyethylene. Translucent tank walls or gauge glasses shall have permanent graduation markings at 10 litre intervals. Tank capacities shall be as indicated. Tanks shall have close-fitting lids designed to enable easy decanting of chemicals.

2.15.4.4 Where each boiler has its own high pressure feed water pump, the chemical solutions shall be injected into the low pressure feed water line as close to the pump as practical.

2.15.4.5 Where boilers are supplied with feed water from a common high pressure system the chemical solutions shall be injected into the high pressure feed water lines as close to the boilers as practical.

2.15.4.6 Injector pumps shall be controlled in tandem with the boiler high pressure feed water pumps or valves as relevant. Injection rates shall be capable of fine adjustment over approved ranges. High pressure injector pumps can be electric or hydraulically driven by feed water pressure. Low level sensors in the mixing tanks shall stop pumps before they run dry and sound the plant room alarm.

2.15.4.7 Dosing pots shall be provided to enable shot dosing of chemical solutions direct into each steam boiler close to the water surface level. The pots shall have a filling arrangement enabling easy decanting of the chemical solutions, and the valves and connections necessary for injection by feed water pressure. Drains shall be permanently connected to the drainage system.

2.15.5 Filling Hot Water Installations

2.15.5.1 HTHW and MTHW systems shall be filled with de-mineralised water containing 50 mg/litre dissolved solids, or less as indicated. Make-up water for these systems shall be de-mineralised by pre-treatment plant; see Section 2.15.2.

2.15.5.2 LTHW systems with boilers having high heat release rates or modular boilers of low water content shall be filled with softened water having a Total Hardness less than 5 mg/litre as $CaCo_3$. Other LTHW systems shall be filled with mains water or a blend of mains water and de-mineralised water, having a Total Hardness not exceeding 100 mg/litre as $CaCo_3$ unless otherwise indicated. (Mains water blended with base-exchange softened water will not be accepted).

2.15.5.3 Where LTHW systems are to be filled with fully softened water the associated make-up water systems shall include water pre-treatment plant in accordance with Section 2.15.2. Where LTHW systems are to be filled with raw mains water or blended water, make-up water can be taken direct from the mains.

2.16 CHEMICAL CONDITIONING EQUIPMENT FOR HOT WATER INSTALLATIONS

2.16.1 For HTHW and MTHW systems, and LTHW circuits connected to MTHW injection sets, a chemical dosing installation shall be installed which is designed to match the total water capacity of the system and comprises either:

a) A proprietary combination set including chemical mixing and measuring tank and electrically driven dosing pump. The tank shall be provided with a gauge glass or with suitable graduation marks and with a low level cut-out switch to protect the pump from running dry. The pump shall have a variable delivery with simple manual adjustment, and shall be capable of injecting treatment chemicals into the return main at the full operating pressure; or

b) A heavy duty polyethylene tank, with gauge glass and low level float switch, of not less than 50 litre capacity. It shall be graduated in 5 litre increments and include an electrically driven dosing pump manufactured from chemical resistant materials with manual adjustment of the delivery rate with a maximum delivery and pressure to suit the system requirements.

2.16.2 For LTHW systems a chemical dosing pot shall be connected to the return main of the hot water circuit on a by-pass, with suitable valves, to enable treatment chemicals to be added to the system as required.

2.17 INSTRUMENTATION

2.17.1 All boilers other than those fired by natural draught gas burners shall be provided with a socket in the boiler front and another in the flue exit, or in the flue system within 450mm of that exit, to facilitate the measurement of overfire draught and flue gas parameters respectively. The bore of the sockets is to be sufficient to permit the use of a 10mm diameter portable instrument probe and it is to be closed by a 12mm screwed hexagon headed brass plug.

2.17.2 In steam boiler houses only, the following shall be provided:

a) An integrating feed water meter on each boiler;

b) A dial thermometer on the water outlet from the boiler feed pumps.

2.17.3 In hot-water boiler houses where the total boiler rating exceeds 1200kW the following shall be provided:

a) Multi-point indicator(s) to indicate the following:

boiler water flow temperatures;
boiler water return temperatures;
flow header (when fitted) temperature;
system water flow temperature(s);
system water return temperature(s);
outdoor temperature.

b) BS thermometer pockets with screwed caps shall be fitted beside each temperature sensing point connected to the multi-point indicator(s) so that a check thermometer may be inserted. Pockets shall be of steel except for copper installations where they shall be of brass.

2.17.4 In hot-water boiler houses where the total boiler rating is below 1200kW, dial-type thermometers shall be fixed in each boiler flow and in the common return. A dial-type thermometer shall be fixed similarly in the common flow main after the thermostatic mixing valve when one is fitted. The dial-type thermometers shall be as specified in Section 9.

TABLE 2A SELECTION TABLE FOR BOILER PLANT

Boiler Type	British Standard	Duty and output rating										
		Steam				Hot water						
		Above 10 bar	Below 10 bar pressure			HTHW		MTHW			LTHW	DHWS
			>12 MW	12.0-3.5 MW	<3.5 MW	>3.5 MW	Up to 3.5 MW	Over 3.5 MW	Up to 3.5 MW	<1.0 MW only		
Steel water tube	1113	✓	✓									
Composite	1113 or 2790	✓	✓									
Steel shell 3 pass economic wet back with gas reversal chamber	*855 or 2790	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Steel shell 3 pass economic semi wet back with gas reversal chamber	*855 or 2790				✓							
Steel shell 3 pass reverse flame boiler, with wet, or semi wet back combustion chamber	*855 or 2790				✓		✓		✓		✓	
Steel 'box-type' boiler	*855								✓		✓	
Cast-iron sectional boiler	779									✓	✓	
Continuous-coil steam generator	1113				✓							
Continuous-coil water heater	1113						✓		✓		✓	
Waste heat boiler capable of running in the dry condition	*855 or 1113 or 2790				✓		✓		✓	✓	✓	
Gas fired modular boilers											✓	
Electrode boilers	1894			✓	✓		✓		✓		✓	
Electrical resistance-heated boilers	1894 or 5500				✓				✓			✓
Self de-scaling, direct fired, water heaters												✓

Notes:

1 * BS 855 is restricted to steam boilers of rates output 45kW to 1500kW with a maximum operating pressure of 2 bar, and to hot water boilers of rated output 45kW to 3MW with a maximum operating pressure of 4.5 bar and a maximum operating temperature of 132°C. In cases where the above limits are exceeded BS 2790 will be applicable.

2. All pressures quoted in this table are gauge.

Section Three—Pumping Equipment

3.1 CIRCULATING PUMPS

3.1.1 General

3.1.1.1 Values of the resistance to fluid flow of items of equipment, pipework and/or the total distribution system indicated in the contract documents are approximate.

3.1.1.2 It shall be the responsibility of the Contractor to verify these values and provide pumps capable of delivering the required volume when operating against the actual total system resistance.

3.1.1.3 Pumps shall comply with the requirements of BS EN 60335-2-51 : 1991, BS 4082 Parts 1 and 2 and BS 5257, as applicable.

3.1.1.4 Pumps shall be 'type' tested in accordance with the requirements of BS 5316 Part 1 and shall be selected to give the correct fluid flow rate. Unless otherwise indicated, test certificates and performance curves shall be submitted.

3.1.1.5 Unless otherwise indicated pumps and their drives shall be segregated such that failure of pump seals shall not result in damage to drive motors.

3.1.1.6 All pumps except draining pumps shall be installed with a valve on suction and delivery connections.

3.1.1.7 Pumps shall be provided with anti-vibration mountings and flexible connections where indicated.

3.1.1.8 The Contractor shall be responsible for providing all dimensions and details to enable pump bases to be set out.

3.1.2 LTHW AND MTHW HEATING AND DHWS SYSTEMS

3.1.2.1 Horizontal or vertical circulators shall be electrically driven and of the following types:

a) Centrifugal type, close coupled, or with direct or approved indirect drive and taper connections where necessary on suction and delivery ports. Direct drive pumps and motors shall be mounted on a common bed-plate.

b) In-line pumps with connections of a different size to the main pipework may be used subject to the approval of the PM. Eccentric reducers shall be correctly fitted at suction and delivery ports.

c) For LTHW and MTHW systems only, purpose designed pumps of the 'canned rotor' or similar glandless type may be used.

d) For DHWS systems, pumps shall be as described for LTHW and MTHW systems immediately above but shall have body castings of gunmetal.

3.1.2.2 Each circulating pump shall be installed with a valve on the inlet and a valve on the outlet connections.

3.1.2.3 Shafts shall be corrosion resistant. Shaft seals shall be dripless mechanical or packed gland type as indicated. Pumps with packed glands shall have shafts hardened as necessary. Where a lantern ring is fitted it shall be non-metallic. Gland packing material and construction shall be suitable for the operating conditions and shall be approved by the PM. Packed glands shall be provided with separate drip pipes, run to discharge visibly over a tundish or water drainage gulley.

3.1.2.4 Bearings shall be either sleeve type with oiling ring and reservoir, or ball or roller type with grease lubricator or sealed for life. The bearings shall be outside the stuffing box and shaft seal.

3.1.2.5 Each floor-mounted circulating set shall be properly levelled, bolted down and grouted-in, on a brick or concrete base provided by the Building

Contractor to details supplied by the Contractor. Base height to the underside of the pump shall be 300mm minimum. Anti-vibration mountings and flexible connections shall be provided as indicated. The Contractor shall ensure that the complete unit is effectively balanced to eliminate noise and vibration. Belts, where fitted, shall be correctly aligned and tensioned.

3.1.2.6 Pressure gauges shall be connected to the main on each side of the circulator. Where duplicate pumps are provided the gauges shall be connected to the common suction and delivery mains. The gauges shall be provided with air venting facilities, flanged backs, and shall be mounted at the same horizontal level. In all other respects they shall be in accordance with Clauses 9.2.1 to 9.2.3.

3.1.3 HTHW Heating Systems

3.1.3.1 Centrifugal pumps shall be of the types detailed in Clause 3.1.2.1(a) and shall comply with the requirements of Clauses 3.1.2.2 to 3.1.2.6 as appropriate.

3.1.3.2 Pumps shall have cast steel bodies, corrosion resistant steel shafts and nickel-iron impellers. Alternative materials suitable for the operating conditions will be considered provided they are fully detailed by the Contractor.

3.1.3.3 The pump construction and layout shall allow use of a standard mechanical shaft seal suitable for the water temperature, and standard ball and sleeve bearings. Seal faces shall be selected to suit the water condition (ie. with/without abrasive particles).

3.1.3.4 Inlet and outlet ports shall be flanged and provided with taper connections if necessary.

3.2 BOILER FEED PUMPS

3.2.1 Other than for electrode boilers, feed pumps shall be electrically driven centrifugal type, horizontal or vertical pattern, arranged for direct drive through a resilient coupling. Horizontal pattern pumps and motors shall be mounted on a common bed-plate. The pump sets shall be supported on brick or concrete bases, or be integral with a packaged steam boiler. All parts of the pumps in contact with condensate shall be of corrosion resistant material.

3.2.2 Feed pumps for electrode boilers shall be electrically driven, and of the positive displacement screw or gear type fitted with an integral pressure relief valve.

3.2.3 Shaft seals shall be provided in accordance with Clause 3.1.2.3.

3.2.4 Bearings shall be as specified in Clause 3.1.2.4. Each bearing shall be housed in a pedestal separate from the gland seal.

3.2.5 Inlet and outlet ports shall be flanged and provided with taper connections. Each pump when not supplied as an integral part of a packaged steam boiler, shall be mounted as specified in Clause 3.1.2.5.

3.3 CONDENSATE PUMPS AND RECEIVER SETS

3.3.1 Pumps shall be electrically-driven centrifugal type, unless otherwise indicated, arranged in duplicate with manual changeover. Pump casings shall be of cast iron or gunmetal as indicated. Shafts shall be corrosion resistant and impellers shall be of gunmetal.

3.3.2 Design of the pumps and the installation shall be such that condensate at temperatures up to 98°C can be handled without damage occurring due to cavitation.

3.3.3 Pumps may be of the horizontal or vertical type, resiliently connected, direct coupled, or indirectly coupled with vee-belt drive and facilities for belt tensioning mounted on a common bed plate or chassis.

3.3.4 Shaft seals shall be provided in accordance with Clause 3.1.2.3.

3.3.5 Bearings shall be as specified in Clauses 3.1.2.4 and 3.2.4.

3.3.6 Inlet and outlet ports shall be flanged.

3.3.7 Condensate receivers shall be of heavy gauge welded steel or copper construction, and shall be supported on a steel base. Steel receivers shall be painted internally and externally with two coats of anti-corrosive solution (see Clause 5.6.1). Each receiver shall be complete with the following:

a) Bolted access cover

b) Condensate level gauge glass

c) draining cock or valve

d) Connections for condensate return and pump suction

e) Separate vent and overflow pipes not less than 40mm size and so arranged that the discharge will avoid structural damage or injury to personnel

f) High and low water level pump controls

g) Purpose-built support frame of mild steel, galvanised after assembly

h) Sheet lead pads fitted on the bearing surfaces of all copper receivers.

3.3.8 Steam-powered pumping sets where indicated shall be packaged units comprising automatic pump complete with inlet and outlet check valves, float, vented receiver and ancillary equipment assembled into a frame. A flow counter device shall be fitted to each pump.

3.4 SEMI-ROTARY HAND PUMPS

3.4.1 Semi-rotary hand pumps shall be manufactured from materials suitable for the particular requirements. Those for boiler house and plant room drainage shall be suitable for use with hot water at temperatures up to 98°C.

3.4.2 For the drainage of oil storage catchpits, shaft seals of the 'O' ring pattern shall be used.

3.4.3 Pumps shall have a foot valve and strainer and be fixed securely in a position to allow for ease of manual operation.

3.5 OIL CIRCULATING AND OIL TRANSFER PUMPS

3.5.1 Oil pumps shall be electrically driven positive displacement screw or gear type or, for use with BS 2869: Part 2 Class D oils, of centrifugal type, suitable for the viscosity and temperature of the grade of oil to be pumped. An integral pressure relief valve shall be fitted to positive displacement pumps.

3.5.2 Pumps for transferring oil from a bulk storage tank to a service tank shall be started manually and switched off automatically by means of a float switch fitted in the service tank.

3.5.3 Each floor mounted circulating set shall comply with Clause 3.1.2.5.

3.6 FIRE PROTECTION SYSTEM PUMPS

3.6.1 Pumps providing a water supply to a sprinkler installation shall comply with the requirements of BS 5306: Part 2.

Section Four—Distribution Installation

4.1 TUBES AND PIPES

4.1.1 Tubes and pipes used for LTHW, MTHW, HTHW, steam, condensate, DHWS and cold water services, shall be as indicated in Table 4B.

4.1.2 Tubes and pipes used for natural gas, LPG, oil fuel and fire protection services, shall be as indicated in Table 4C.

4.1.3 Steel pipework shall be ungalvanised with the exception of the following which shall be galvanised:

a) Drain pipework.

b) Vent pipework.

c) Overflow pipework.

d) DHWS pipework as indicated.

e) Cold Water Service pipework.

f) LPG pipework (where indicated).

g) Fire protection system pipework (where indicated).

4.1.4 Pipework designated as 'concealed' in Tables 2 and 3 shall include all pipework in chases, ducts, service shafts, partitions, ceiling voids, floors etc. It shall not include short lengths of pipework passing through the building structure.

4.1.5 Pipe 'risers' used for natural gas services inside multi-storey buildings (buildings more than 5 storeys and over 20m high) shall not exceed DN100 and shall be mild steel to BS 1387 or carbon steel to BS 3601 S or ERW 410 of wall thickness as indicated.

4.1.6 Polyethylene tubes for natural gas or LPG services shall be for below ground application only, and shall not be exposed to daylight or to ultra-violet light sources during transit and storage.

4.2 PIPEWORK JOINTS AND FITTINGS

4.2.1 LTHW and MTHW Systems

4.2.1.1 Joints on galvanised pipework shall be screwed.

4.2.1.2 The following LTHW pipework joints shall be welded:

a) Concealed pipework.

b) Pipework over DN 100.

c) LTHW systems connected to MTHW injection sets.

All other LTHW pipework may have screwed or welded joints.

4.2.1.3 All MTHW pipework joints shall be shall be welded.

4.2.1.4 Where screwed joints are allowed, the male component shall be taper threaded to BS 21 and the jointing between them shall be PTFE tape to BS 7786 unless otherwise indicated.

4.2.1.5 Threaded fittings shall be malleable cast iron, banded or beaded pattern, manufactured in accordance with BS 143 and 1256 and BS EN 10242, galvanised to match associated piping as necessary.

4.2.1.6 Butt welding pipe fittings shall comply with BS 1965.

4.2.1.7 Flanges for steel pipework shall be forged steel. Headers shall be of flanged steel tube with flanges welded on. Spare outlets shall be blanked with bolted flanges.

4.2.1.8 At dismantling points and where the pipework is connected to an appliance, spherical seated unions shall be used for pipework up to DN 50, and flanges shall be used for pipework DN 65 and above.

4.2.1.9 Flanges shall be raised face to BS 4504 Part 3 Section 3.1, Tables 9. Exceptionally, where flanged connections are made to existing equipment having flanges of Imperial sizes, the flange shall be flat faced to BS 10, Table A for LTHW systems, and Table D for MTHW systems, appropriate to the temperature and working pressure.

4.2.1.10 Where flanged connections are made to copper alloy valves, with flat faced flanges to BS 4504: Part 3, Section 3.3, the raised face of the mating flange shall be removed and the resulting machined surface shall comply with the tolerances quoted in BS 4504: Part 3.2.

4.2.1.11 Metric bolts of the correct diameter shall be used with flanges to BS 4504. Where Imperial bolts are unobtainable for use with existing Imperial flanges, Metric bolts shall be used as follows:

Bolt Hole Diameter (Inches)							
9/16	5/8	11/16	3/4	13/16	7/8	15/16	1
Metric Bolt (M)							
12*	14	16	18	18*	20*	22	24

Where bolts are marked thus * washers shall be fitted under the bolt heads and nuts.

4.2.1.12 Flanged joints shall be made with gaskets to BS 4865: Part 1, or BS 3063 as appropriate. They shall be of a grade and thickness suitable for the temperature, pressure and operating conditions of the service and shall be approved by the PM.

4.2.1.13 Proprietary grooved pipe jointing systems using elastomeric seal rings may be used up to a maximum temperature of 95°C and a maximum pressure of 9.5 bar with the approval of the PM. These shall be suitable for the temperature, pressure and operating conditions of the service. Manufacturer's recommendations on pipe wall thickness, methods of groove forming, groove dimensions, seal materials and limiting operational loads shall be followed. Piping ends shall be within the recommended tolerances and shall be free from burrs and distortion.

4.2.2 HTHW Systems

4.2.2.1 Where galvanised pipework is used (to the direction of clause 4.1.3) the joints shall be screwed.

4.2.2.2 Joints in pipelines and at fittings shall be welded. Butt-welding pipe fittings shall comply with BS 1965.

4.2.2.3 Steel welding neck or slip-on boss flanges shall be used for connections to valves and at dismantling points.

4.2.2.4 Flanges shall be raised face and suitable for the operating temperature and pressure selected from the appropriate tables in BS 4504: Part 3.1. Exceptionally, where flange connections are made to existing equipment having flanges of Imperial sizes, the connecting flange shall be flat faced to BS 10 Table E.

4.2.2.5 Where appropriate there shall be compliance with Clauses 4.2.1.10 and 4.2.1.11.

4.2.2.6 Flanged joints shall be made with gaskets inside the bolt circle to BS 4865: Part 1, or BS 3063 as appropriate. They shall be of a grade and thickness suitable for the temperature, pressure and operating conditions of the service and shall be approved by the PM.

4.2.3 Steam Systems

4.2.3.1 Joints in steam pipework up to DN50 conveying steam at up to 3.5 bar and not concealed (Clause 4.1.4) may be either welded, or have taper threads as Clause 4.2.1.4. All other joints shall be welded.

4.2.3.2 Threaded fittings shall be malleable cast iron to BS 143 and 1256 and BS EN 10242 or wrought steel to BS 1740.

4.2.3.3 Butt-welding pipe fittings shall comply with BS 1965.

4.2.3.4 At dismantling points and where pipework is connected to an appliance, bronze seated malleable iron unions shall be used on pipework up to DN50 conveying steam at up to 3.5 bar. All other connections shall be flanged.

4.2.3.5 Flanges shall be suitable for the operating temperature and pressure and shall comply with Clauses 4.2.1.10, 4.2.1.11, 4.2.2.3, 4.2.2.4 and 4.2.2.6 as appropriate.

4.2.4 Condensate Systems

4.2.4.1 Joints in steel condensate pipework shall comply with Clauses 4.2.3.1 to 4.2.3.5 as appropriate.

4.2.4.2 Joints in copper condensate pipework shall be made with compression fittings to BS 864 Part 2 or by brazing. Screwed joints may be used with the prior approval of the PM outside buildings or where several fittings are installed closely together in the condensate system.

4.2.4.3 Threaded fittings in copper pipework shall be of copper alloy to BS 143 and BS 1256 and shall be threaded to BS 61. Unions or flanges may be used for connecting to traps, strainers and other items of plant and equipment.

4.2.4.4 Flanges for copper pipework shall be of composite type to BS 4504: Part 3, Section 3.3 comprising copper alloy inserts brazed to the tube with loose steel locking rings. Flange connections shall comply with Clause 4.2.1.11 and 4.2.1.12 as appropriate.

4.2.5 Water Systems

4.2.5.1 All water systems shall comply with to Local Authority Regulations.

4.2.6 DHWS Systems

4.2.6.1 These shall be stainless steel, copper or galvanised steel with stainless steel or copper dead-legs as indicated.

4.2.6.2 Joints on galvanised pipework shall be screwed, except at dismantling points where they shall be flanged.

4.2.6.3 Fittings for copper pipework up to and including DN50 shall be of the capillary or compression type to BS 864: Part 2. Capillary fittings shall be either lead-free solder ring or end feed type as indicated. Lead free solder shall be used on all hot and cold water service systems. Fittings shall be resistant to dezincification where recommended by the Water Company and as approved by the PM. Joints over DN50 shall be brazed or flanged as Clause 4.2.4.4.

4.2.6.4 Pipework shall be arranged to allow easy dismantling. Dismantling points in copper pipework up to and including DN50 shall be unions, otherwise they shall be flanged.

4.2.6.5 Where internal cold water services do not form part of the Works, the DHWS system shall terminate within 450mm of each sanitary fitting or range of appliances.

4.2.7 Cold Water Services

4.2.7.1 These shall be stainless steel, polythene, PVC, other plastics, copper or galvanised steel as indicated.

4.2.7.2 Copper systems shall comply with Clauses 4.2.6.3 and 4.2.6.4.

4.2.7.3 Fittings for stainless steel pipe shall be stainless steel capillary or compression types. Socket length of capillary type straight couplings shall be to BS 864: Part 2. Compression fittings shall be of grade 316 stainless steel.

4.2.7.4 Polyethylene and PVC, or other approved plastics pipes, shall have compression fittings to BS 864: Part 3 or solvent welded fittings to BS 4346: Part 1. Where approved by the PM, mechanical joints to BS 4346: Part 2, or joints suitable for ABS or PB pipework may be used.

4.2.7.5 Galvanised steel systems shall comply with Clause 4.2.6.2.

4.2.7.6 Cleaning and sterilisation shall be carried out as specified in Clause 12.3.7.

4.2.8 Natural Gas Services

4.2.8.1 Installation, pipework, joints and fittings shall be in accordance with IGE Utilization Procedures IGE/UP/2.

4.2.8.2 Where pipework is to be buried in the ground, the Contractor shall mark out the position of the trenches to be excavated and shall indicate where concrete is required for pipe supports. The trench shall provide a minimum cover of 750mm. Where a common excavation is made for gas pipes and electric cables, a minimum clearance of 300mm shall be maintained between the two services. Depending on the nature of the subsoil, and where required by the PM, the gas pipes shall be bedded and covered with soft sand to a thickness as indicated.

4.2.8.3 Steel pipework buried in the ground shall be protected against corrosion as indicated.

4.2.8.4 Iron pipework shall be slung and sounded before laying. An approved plunger or disc stopper shall be drawn through the pipework as the work proceeds.

4.2.8.5 Within buildings the Contractor shall arrange for dismantling points at intervals not exceeding 24m and at such other points as required by

the PM. For this purpose unions shall be used on pipework up to DN50, and flanges on pipework DN65 and above.

4.2.8.6 A minimum clearance of 150mm shall be maintained between gas pipes and electric cables, conduits etc, in all internal installations and above ground external installations.

4.2.8.7 Pipes shall be laid to a fall of not less than 1 in 240.

4.2.9 LPG Vapour Distribution Systems

4.2.9.1 Pipework shall be steel, PE tube or copper.

4.2.9.2 Joints in steel pipework DN50 and under shall be welded, flanged or screwed. Joints in steel pipework DN65 and above shall be welded or flanged.

4.2.9.3 Joints in copper pipework shall be either compression type or silver soldered or brazed.

4.2.9.4 Joints in polyethylene tube shall be made with clamped or compression fittings complying with Clause 4.2.9.7 or may be fusion jointed to British Gas Corporation Standard Specification BGC/PS/PL2.

4.2.9.5 Fittings for steel pipes shall be of steel. Flanges shall be suitable for the temperature and pressure as selected from the appropriate tables of BS 4504: Part 3, Section 3.1, or from BS 10 when connection is made to existing equipment having flanges of Imperial sizes. Bolting shall be to BS 4882. Flange connections shall comply with Clauses 4.2.1.10, 4.2.1.11 and 4.2.1.12 as appropriate. Butt welding fittings shall be to BS 1965. Socket welding and threaded fittings shall be to BS 3799.

4.2.9.6 Fittings for copper pipes shall be of forged brass or gunmetal to BS 864. Compression fittings shall only be used in accessible positions.

4.2.9.7 Fittings for polyethylene tube shall be of gunmetal resistant to dezincification to British Gas Corporation Standard Specifications BGC/PS/PL2 and BGC/PS/PL3.

4.2.9.8 The requirements of Clauses 4.2.8.2, 4.2.8.3, 4.2.8.6 and 4.2.8.7 shall apply as appropriate.

4.2.10 Oil Fuel Systems

4.2.10.1 Steel pipework shall have welded joints using butt welding fittings to BS 1965. Joints and fittings for copper pipework shall comply with Clauses 4.2.6.2 and 4.2.6.3, as appropriate, except that soft solder fittings shall not be used and compression fittings shall only be used where required to facilitate dismantling. Galvanised pipework shall not be used.

4.2.10.2 Protection of external buried steel pipework shall be as indicated. Where indicated a non-corrodible secondary containment system shall be provided in accordance with Environment Agency requirements.

4.2.11 Fire Protection Systems

4.2.11.1 Fire protection systems shall comply with BS 5306: Parts 1 and 2 as appropriate.

4.2.11.2 Fittings used with galvanised pipework shall be galvanised.

4.2.11.3 Where joints and fittings are threaded they shall comply with Clauses 4.2.1.4 and 4.2.1.5.

4.2.11.4 Proprietary grooved pipe jointing systems shall comply with the requirements of Clause 4.2.1.13.

4.2.11.5 Fittings to which Fire Brigade connections will be made shall comply with the requirements of the Fire Fighting Authority.

4.3 WELDING

4.3.1 Unless otherwise indicated steel pipework complying with BS 1387 or BS 3601 with diameters and wall thicknesses not exceeding DN200 and 20mm respectively shall be welded in accordance with the recommendations in HVCA/JIB Recommended Practice and Tests for Competency 1990 (Formerly known as TR/5), as modified below. Steel pipes of larger diameters and greater thicknesses shall be welded in accordance with BS 2971, BS 2640, or other specifications as indicated or approved by the PM.

4.3.2 Joint designs, welding procedures, welder certification and production weld quality shall comply with the requirements as interpreted by the appointed Inspection Body: see Section 12.

4.3.3 Unless otherwise indicated joint designs, welding procedures and welders' competency tests shall be as described in the Recommended Practice and Tests. Prior approval shall be obtained to the installation of gusseted bends.

4.3.4 Welders shall hold current certificates of competency validated by the appointed Inspection Body, or similar approved body. Welders without validated current certificates shall undertake the relevant standard tests, witnessed and certified by the appointed Inspection Body before commencing work. Welders with validated certificates who lack relevant

welding work experience in the preceding 3 months, and other welders as directed by the PM, shall undertake the relevant tests witnessed and certified by the appointed Inspection Body before commencing work.

4.3.5 Welders shall permanently identify each of their welds with their own marker which will withstand site conditions without damaging system or component performance. Methods of marking shall be approved.

4.3.6 Welds in unconcealed LTHW and fire protection system pipework shall be visually inspected to BS 5289, and copies of the records shall be given to the PM. Welds will be checked by the appointed Inspection Body at the time the pipework is pressure tested. Where the appointed Inspection Body is not satisfied, the welds shall be subjected to the non-destructive testing procedures described in Clause 4.3.7.

4.3.7 Unless otherwise indicated welds in MTHW, HTHW, steam and gas pipework, and in LTHW pipework which is to be concealed, shall be subjected to a programme of non-destructive testing in accordance with the relevant Standards. The method of testing shall be ultrasonic or radiographic in accordance with BS 3923 or BS 2910 respectively, as approved by the PM. Tests shall be carried out by certified competent persons recognised by the appointed Inspection Body. Copies of the test reports shall be given to the appointed Inspection Body and the PM to permit full consideration whilst the relevant welds remain exposed. The NDT programme shall include:

a) testing one of the first 5 production welds made by each welder.

b) testing 10% of the subsequent production welds made by each welder.

c) in the event of finding a faulty weld, at the discretion of the PM, the testing of a further 2 welds made by the relevant welder.

4.3.8 The welds to be tested in compliance with Clause 4.3.7 shall be randomly selected by the PM.

4.3.9 Welds found to be defective shall be rectified to a standard complying with BS Class II specifications to the satisfaction of the appointed Inspection Body. At the discretion of the PM, rectification work shall be carried out by different welders. Welders with failure rates considered excessive by the appointed Inspection Body shall be taken off the Works at the discretion of the PM.

4.4 BRAZING

4.4.1 Copper pipework up to DN200 with wall thicknesses up to 4.5mm shall be brazed in accordance with the recommendations in HVCA/JIB Recommended Practice and Tests for Competency 1990 (Formerly known as TR/3), as modified below. For other pipe sizes and wall thicknesses, brazing shall be carried out in accordance with BS 1723, or other specification as indicated or approved by the PM.

4.4.2 Joint designs, brazing procedures, brazer certification and production joint quality shall comply with the requirements as interpreted by the appointed Inspection Body see clause 12.1.1. Section 12.

4.4.3 Unless otherwise indicated or approved filler metal shall be AG2 to BS 1845.

4.4.4 Brazing procedures shall include auxiliary heating for pipe sizes DN75 and larger, for solid copper flanges, and in other circumstances where exposure weather, wall thickness etc, indicate sound joints will not be otherwise assured.

4.4.5 Brazers shall hold a valid certificate of competency issued by the appointed Inspection Body or similar approved body. Unless otherwise indicated the Code of Practice TR/3 standard test piece will be the accepted test of competency. Brazers without valid certificates and those without relevant brazing work experience within the preceding three months shall undertake the TR/3 test, witnessed and certified by the appointed Inspection Body, before commencing work.

4.4.6 Brazers shall permanently identify each of their joints with their own marker which will withstand site conditions without damaging system or component performance. Methods of marking shall be approved.

4.4.7 A proportion of the joints made by each brazer each day shall be cut out and subjected to destructive testing under the supervision of the appointed Inspection Body. In the event of finding a faulty joint a further 2 joints made by the relevant brazer shall be cut out and tested. Joints shall be selected for test at the discretion of the PM up to the numbers as indicated. Cutting out and consequential repair works shall be carried out by the contractor at his expense.

4.4.8 Visual examination and non-destructive testing of joints will be carried out by the appointed Inspection Body during the system pressure tests. The test criteria shall be those stated in Code of Practice TR/3.

4.4.9 At the discretion of the PM rectification work on faulty joints shall be carried out by different brazers. Brazers with failure rates considered excessive by the appointed Inspection Body shall be taken off the Works at the discretion of the PM.

4.5 ANCILLARY EQUIPMENT

4.5.1 Pipework Supports

4.5.1.1 Pipework shall be supported adequately in such a matter as to permit free movement due to thermal expansion and contraction. Pipework supports shall be arranged as near as possible to joints, and the spacings shall not exceed those given in Tables 4 and 5. Where pipes are thermally insulated the insulation shall be carried through the support. Where there are two or more sizes of pipes, the common support spacings shall be those required by the smallest bore pipework. Supports for natural gas pipework shall comply with the requirements of IGE Utilization Procedures IGE/UP/2.

4.5.1.2 Plastic pipework shall be continuously supported as far as possible. Where this is impracticable the spacings of the supports shall not exceed those indicated in the appropriate tables in BSCP 312: Parts 2 and 3.

4.5.1.3 Branches from vertical pipework shall not be used as a means of support for risers.

4.5.1.4 Brackets for mild steel pipework shall be mild steel or malleable iron with ferrous fixings. Brackets for copper pipework shall be brass or gunmetal with non-ferrous fixings.

4.5.1.5 Where pipework up to 50mm size is fixed to solid walls, brackets may be of the screw-on or long shank built-in type, except where the walls are plastered when only the long shank built-in type shall be used. For fixing to woodwork and lightweight partitions or walls, brackets shall be screw-on pattern and may be adjustable two-piece type. The detachable part of a pipe clip shall be capable of removal without disturbance of the fixing or adjacent pipes. Allowance shall be made in the support for the thickness of thermal insulation where required. Cast-iron and steel spigot and socket pipework shall be supported at each joint on mild steel angle or tee brackets embedded not less than 115mm into walls. Pipework shall be secured to the brackets by 'U' bolts or mild steel stirrup bolts.

4.5.1.6 Brackets screwed to walls shall be secured by expanding plugs or other purpose designed fixing devices; wooden plugs will not be accepted.

4.5.1.7 Pipework subject to expansion and contraction and hung from supports shall be suspended on swivel hangers unless otherwise approved.

4.5.1.8 Hangers for horizontal pipework at high level shall be adjustable mild steel supported from mild steel angle or channel sections, supplied by the Contractor, suitable for building-in or otherwise securing to the structure by the Building Contractor. Welding to the structure shall not be undertaken without the prior approval of the PM. Pipe rings shall be of malleable cast-iron or fabricated steel, made in halves and secured by bolts or screws. Alternatively, malleable iron hinged pipe rings may be used. Calliper hooks will not be accepted. Proprietary pipework suspension systems may be used with the approval of the PM.

4.5.1.9 Where pipework is fitted in ducts or trenches, or where DN65 or greater, supports shall be of the type indicated. Allowance shall be made for thermal insulation to be applied to the requirements of Section 10. Load-bearing insulation at supports shall be fitted by the Contractor at the time of erecting the pipework (see Clause 10.3.5).

4.5.2 Anchors

4.5.2.1 On mild steel pipework, mild steel anchors capable of resisting the maximum stresses shall be provided and preferably shall be welded to the pipework. Where it is not practicable to weld the anchors to the pipework, cast-iron chairs with at least two wrought-iron stirrup bolts shall be used, the bolts to have sufficient thread to ensure an effective grip on the pipe. For copper pipework the anchors shall be provided by wide copper straps secured to the pipework in such a manner that the pipe is not damaged. The Contractor shall supply, and fix in position ready for building-in, all cleats, brackets and steelwork required for anchor points. Steelwork in trenches or ducts to which anchors are attached shall be hot-dip galvanised. Anchors shall have two coats of aluminium paint.

4.5.3 Expansion Devices

4.5.3.1 Provision for movement due to thermal expansion and contraction shall be made by changes in direction of the pipework, by loops or by special expansion joints approved by the PM. Measures shall be taken to prevent the movement of pipework causing damage to thermal insulation.

Supports and guides shall be arranged to ensure that movement is taken up as intended. Where pipework is required to be pre-stressed, the extent of the cold pull shall be as indicated. Fixing bolts for flanged joints shall not be used for taking up cold pull allowance.

4.5.3.2 Expansion joints may be of the articulated or axial type as indicated and have screwed or flanged ends as appropriate. Internal liners shall be incorporated if required, manufactured from a corrosion-resistant steel, or other approved material appropriate to the duty, and designed to withstand the test pressure of the system. Expansion joints shall be capable of not less than 2000 complete cycles of movement over the designed working range.

4.5.3.3 Expansion joints for angular movements shall be provided with tie rods or hinges to take end thrust, and shall comply in general with Clause 4.5.1.1.

4.5.3.4 Expansion joints shall be provided with external protection against damage where indicated. The method of protection shall be approved by the PM.

4.5.3.5 Expansion joints shall be installed so that they are not subjected to stresses other than those for which designed. Installation shall ensure joints are in the free position at a temperature midway between the high and low limits of normal service.

4.5.3.6 Expansion joints shall have guides to ensure that all movements are taken up in the designed manner. Expansion joints shall be installed in accordance with the manufacturer's recommendations. On completion of installation and before heat is applied to the system the Contractor shall obtain certification that the installation is in accordance with the manufacturers' instructions. Guides shall be rigidly secured and allow freedom of movement for pipe expansion without excessive clearance. Lubrication points shall be provided where necessary.

4.5.4 Air Venting

4.5.4.1 Devices for air release shall be provided at all high points.

4.5.4.2 Air bottles for LTHW systems shall be made from DN50 tube approximately 230mm long fitted with a cap and size 3/8 air cock; these shall be fitted to equal tees or have DN50 connections if the main is larger than DN50. Where an air bottle is fixed out of reach a DN10 extension tube shall be run from the cap to within 1.5m of the floor, terminating with a size 3/8 needle-seated globe valve or air cock.

4.5.4.3 Air bottles for MTHW and HTHW systems shall be of welded construction. On pipework up to and including DN80 each bottle shall be manufactured from DN50 tube 300mm long with a cap. Air bottles on pipework DN100 and over shall be manufactured from DN100 tube each 380mm long with a cap. All air bottles shall be complete with DN15 tube from the top brought down to within 1.5m of the floor and fitted with a DN15 lockable flanged globe valve. The open ended outlet pipe from the valve shall discharge at a position approved by the PM.

4.5.4.4 Automatic air vents, suitable for the system temperature and pressure, shall be used only where indicated and have malleable iron, nodular iron, gunmetal or brass bodies, as indicated, with non-ferrous or stainless steel floats and guides and non corrodible valves and seats. Each air vent shall have a lock-shield valve. Air release pipes shall be run to discharge at the nearest suitable visible safe point.

4.5.4.5 Air vent and air release pipes installed where freezing is likely to occur shall be insulated.

4.5.5 Emptying Down, Draining and Flushing

4.5.5.1 Steel pipework from drain valves or cocks shall be galvanised.

4.5.5.2 Drain valves or cocks shall be lockable except where prohibited by the Water Company.

4.5.5.3 In addition to the requirements of clauses 4.5.5.4 and 4.6.12, for emptying purposes, 15mm minimum size drain cocks or valves, with hose connections, shall be fitted at all low points of LTHW, MTHW, DHWS and cold water systems.

4.5.5.4 Where a pipe dips under a door into an accessible floor chase a 15mm plugged outlet shall be fitted to LTHW, MTHW, DHWS and cold water systems.

4.5.5.5 For HTHW systems, drain points with flanged valves of the sizes indicated shall be installed at all low points. Valves shall be lockable needle-seated globe type.

4.5.5.6 In LTHW, MTHW and HTHW systems, where indicated, facilities shall be included to permit pre-commissioning cleaning of pipework. These facilities shall include the following:

a) In systems, where pipework sizes are DN40 to DN200 inclusive (other than those in which boiler flow and return headers are fitted with spare blanked connections), a flushing connection shall be fitted to the common flow from the boiler(s) and the common return to the boiler(s). These connections shall be of the same size as the largest pipe size of any sub-circuit. Additionally, at intervals not exceeding 100m, an isolating valve immediately preceded by a drain valve, shall be included in all the circuit pipework. The drain valves shall be of the straight through lockable type and shall be line size for pipework up to DN40 and DN50 otherwise.

b) For pipework sizes exceeding DN200 provision shall be made for flexible or rigid lance water jetting. Flanged make-up pieces, three pipe diameters in length shall be fitted at intervals not exceeding 100m to facilitate access.

On completion of pre-commissioning cleaning, and before final filling, the flushing connections shall be blanked and the drain valves locked in the closed position.

4.5.5.7 Steam and condensate mains shall be graded to fall in the direction of flow unless indicated otherwise. The minimum gradient shall be 1 in 300. Drainage and relay points shall be provided at the lowest points in the mains. Drainage points and scale pockets shall consist of a short length of vertical tube extending downwards from a tee on the main. The diameter of the tube and the connection shall be not less than DN50 or the same diameter as the main. Pockets up to and including DN80 shall be not less than 230mm long and terminate in a screwed cap. Pockets DN100 and above shall be not less than 300mm long and shall be flanged. The drainage connection shall be taken from approximately one-third up from the bottom of the pocket to a strainer and steam trap set.

4.6 GENERAL

4.6.1 Unless otherwise indicated steel and copper pipework systems shall be designed and installed in accordance with BS 806 or BS 1306 as relevant.

4.6.2 Where any of the services referred to in this section require the connection of differently sized items, the Contractor shall be responsible for providing and installing the adaptors.

4.6.3 Joints shall not be made in the thickness of any wall, floor or ceiling, and pipework shall not be embedded in the structure of floors unless approved by the PM. Where pipework passes through walls, floors or ceilings, sleeves shall be provided. Pipework passing through floors shall be provided with approved floor and ceiling plates fastened securely to the pipe. The sleeves shall be of the same material as the pipe. Where a piped service penetrates a structure which is a fire barrier with a designated fire delay characteristic to BS 476: Part 22, the sleeve shall provide a fire stop to comply with the Building Regulations.

4.6.4 Fittings shall be of the same size as the tubes and pipes to which they are connected. Exceptionally where a fitting having the required outlet is not of standard manufacture, the necessary size reduction may be accomplished by the use of one bush for each connection.

4.6.5 Unless otherwise indicated, malleable fittings to BS 143 and BS 1256 shall be used as follows:

a) Elbows to ISO Code Al shall be used in preference to bends to ISO Code Dl.

b) Tees to ISO Code Bl shall be used in preference to pitcher tees to ISO Code El.

4.6.6 Pipework shall follow the contours of walls. The clearance between pipework, fittings, lagging or flanges, and the wall or any other fixtures, shall be not less than 25mm.

4.6.7 Purpose-made bends or springs may be used where it is necessary to deviate from a straight run in non-galvanised pipework. In galvanised pipework deviations shall be formed from standard fittings.

4.6.8 Bends or springs in tubes of DN50 and above shall be hot pulled and the tubes shall remain circular after being set.

4.6.9 Eccentric reducing sockets (ISO Code M3) shall be used where changes of bore are made in runs of nominally horizontal pipework to facilitate air venting and draining.

4.6.10 Before pipework is assembled, the Contractor shall ensure that tubes and tube ends are free from burrs and cutting dross. Tube ends shall be cleaned thoroughly of dirt, rust, scale, paint, oil, etc (see also Clause 12.3.1). Open ends left during the progress of work shall be closed temporarily with purpose-made metal, plastics or wood plugs or caps, or blank metal flanges.

4.6.11 Entry and exit holes for pipework services from buildings shall be sealed and plugged. For service conditions below 60°C the sealant shall be mastic compound; above this temperature the sealant shall be silicone rubber.

Where pipework enters a building through a duct or hole which is considered by the PM to be too large for such treatment, a mild steel blanking plate not less than 6mm thickness shall be built into the walls of the duct or hole. The service pipes shall pass through clearance sleeves (not less than 4 diameters in length) welded into the blanking plate. Annular spaces between pipes and sockets shall be sealed and plugged as above.

4.6.12 Return headers, where indicated, shall be welded with flanged connections and ends. Circuit isolating valves shall be connected direct to a vertical flanged stub on the top of the return header. On the circuit side of the isolating valve a tee shall be fitted with a vertical thermometer in the top reduced outlet. Each circuit return shall have an emptying pipe connected and extended to a drain cock or valve below the level of the header. Headers shall be horizontal and thermometers, drain valves and circuit isolating valves shall each be arranged at common horizontal levels.

4.6.13 Flow headers where indicated shall be welded with flanged connections and ends, and installed to prevent undue stresses on the boilers and the connections.

4.6.14 Unless otherwise indicated both flow and return headers shall be provided with one spare flanged connection. These connections shall be of sizes not less than the largest circuit connections to the headers and they shall be sealed with blank flanges (see also Clause 4.5.5.6).

4.6.15 Metallic pipework systems shall be bonded to BS 7671 and BS 7430:1991 (Code of practice for earthing) see Clauses 11.7.1 and 11.7.2.

4.7 BELOW GROUND DISTRIBUTION PIPEWORK

4.7.1 Below-ground distribution pipework shall comply with the following as indicated:

a) MOD (ex PSA) Standard Specification (M&E) No. 168: Thermally Insulated Underground Piping Systems for the Conveyance of Steam, Hot and Chilled Water.

b) BS 7572:1992—Code of practice for thermally insulated underground piping systems.

c) BS EN 253:1991—Preinsulated bonded pipe systems for underground hot water networks.

d) BS EN 448:1995—Preinsulated bonded pipe systems for underground hot water networks. Fittings assemblies of steel service pipes, PU thermal insulation and outer casing of high density polyethylene.

e) BS EN 488:1995—Preinsulated bonded pipe systems for underground hot water networks. Steel valve assembly of steel service pipes, PU thermal insulation and outer casing of polyethylene.

f) BS EN 489:1995—Preinsulated bonded pipe systems for underground hot water networks. Joint assembly for steel service pipes, polyurethane thermal insulation and outer casing of polyethylene.

4.8 THE ENVIRONMENTAL AGENCY REQUIREMENTS

4.8.1 The requirements of the Agency in respect of double-wall pipe systems shall be met as applicable to the particular installation. Outer casings shall be of non-corrodible material.

4.8.2 Oil storage tanks installed underground shall be double-skinned with GRP or plastics outer skin and interstitial leak detection system incorporated where deemed necessary by the Agency.

4.8.3 The foregoing requirements shall apply to installations within Source Protection Zones. All installations shall conform to those recommended in Agency Publications 2,5,8,15 and 19.

4.8.4 Agency shall be consulted prior to start of installation of any buried oil pipeline or storage tank to establish final local requirements.

4.8.5 Plantroom and boiler room discharge water arrangements shall comply with PPG 15.

TABLE 4A SELECTION TABLE FOR TUBES AND PIPES FOR LTHW, MTHW, HTHW, STEAM, CONDENSATE, DHWS AND CWS INSTALLATIONS

Material	Limitations	BS	LTHW/MTHW				HTHW & Steam		Condensate		DHWS		CWS	
			≤125mm Exposed		*Con	150 to 300 mm	≤125 mm	150 to 300 mm	≤125 mm	150 to 300 mm	20 and 40mm threaded pipe	Other sizes	20 and 40mm threaded pipe	Other sizes
			20, 40 and 65 threaded pipe	Other sizes										
Mild Steel	Galvanised as stated in Section 4.1	1387 medium		✓								✓		✓
		1387 heavy	✓		✓		✓		✓		✓		✓	
Carbon Steel	Wall thickness as indicated	3601 S410	✓	✓	✓	✓	✓	✓	✓	✓				
		3601 ERW 410	✓	✓	✓	✓	✓	✓	✓	✓				
Copper	Working pressure ≤7 bar compression joints	2871 Pt 2, Tab 5							✓	✓				
	Working pressure ≤7 bar screwed joints	2871 Pt 2 Tab 7							✓	✓				
	Working pressure >7 bar compression joints	2871 Pt 2, Tab 6							✓	✓				
	Working pressure >7 bar screwed joints	2871 Pt 2, Tab 8							✓	✓				
		EN1057 Tab X										✓		✓
	Up to 22mm final connections	EN1057 Tab Y		✓										
		EN1057 Tab Z										✓		✓
Poly-ethylene	Class as indicated	6572 and 6730												✓
PVC	Class as indicated	3505												✓
Stainless Steel		4127										✓		✓

* Concealed. See Clause 4.1.4

TABLE 4B SELECTION TABLE FOR TUBES AND PIPES FOR NATURAL GAS, LPG, OIL FUEL AND FIRE PROTECTION INSTALLATIONS

Material	Specification	Natural Gas			LPG Vapour Distribution			Oil Fuel Services				Fire Protection Systems	
		Outside Bldgs	Inside Bldgs		Outside Bldgs	Inside Bldgs		Filling, Vent & Drain Pipes		Feed Pipes	*Con-cealed	20 and 40mm threaded pipe	Other sizes
			20 and 40mm threaded pipe	Other sizes		≤15mm	>15mm	20 and 40mm threaded pipe	Other sizes	All sizes			
Ductile Iron	Spigot and socket to BS EN 545, 596, and 969	✓											
Ductile Iron	Flanged to BS EN 545, 596, and 969	✓											
Mild Steel	BS 1387 Medium see Clause 4.1.3			✓		✓			✓	✓			✓
Mild Steel	BS 1387 Heavy see Clause 4.1.3	✓	✓		✓	✓		✓			✓	✓	
Carbon Steel	BS 3601—Wall thickness as indicated	✓		✓	✓	✓	✓	✓					
Copper	BS EN 1057 Table X			✗		✓				✗			
Poly-ethylene	# Wall thickness to SDR 11	✓			✓								

Notes

\# British Gas Corporation Standard Specification BGC/PS/PL2 Part 1 metric series

* Concealed. See Clause 4.1.4

✗ Less than 42mm size only

TABLE 4C INTERVALS BETWEEN SUPPORT CENTRES FOR STEEL PIPEWORK

Size of tube mm	Horizontal runs		Vertical runs bare or lagged m
	Bare m	Lagged m	
15	1.8	1.8	2.4
20	2.4	2.4	3.0
25	2.4	2.4	3.0
32	2.7	2.4	3.0
40	3.0	2.4	3.7
50	3.0	2.4	3.7
65	3.7	3.0	4.6
80	3.7	3.0	4.6
100	4.0	3.0	4.6
125	4.5	3.7	5.5
150	5.5	4.5	5.5
200	8.5	6.0	8.5
250	9.0	6.5	9.0
300	10.0	7.0	10.0

TABLE 4D INTERVALS BETWEEN SUPPORT CENTRES FOR COPPER PIPEWORK

Size of tube mm	Horizontal runs		Vertical runs bare or lagged m
	Bare m	Lagged m	
15	1.2	1.2	1.8
22	1.2	1.2	1.8
28	1.8	1.5	2.4
35	2.4	1.8	3.0
42	2.4	1.8	3.0
54	2.7	1.8	3.0
65	3.0	2.4	3.7
76	3.0	2.4	3.7
108	3.0	2.4	3.7
133	3.7	3.0	3.7
159	4.5	3.7	3.7

Section Five—Calorifiers, Cylinders Cisterns and Water Tanks

5.1 CALORIFIERS

5.1.1 Storage calorifiers shall comply with BS 853 Grade A or Grade B as indicated.

5.1.2 Non-storage calorifiers shall comply with BS 3274 Type 2 or BS 853 Grade A as indicated.

5.1.3 Each calorifier shall have the following provided:

a) Safety valve.

b) Pressure gauge on the secondary side.

c) Thermometer on the secondary side.

d) Open vent pipe on systems open to atmosphere.

e) Thermostatic and high limit control.

f) Drain cock or tap, operated by a removable key.

g) Graphite type bursting disc as appropriate.

h) Pressure gauge, syphon and cock on the steam side of steam heated calorifiers.

j) Pressure gauge and cock on the primary side of HTHW heated calorifiers.

5.1.4 Bursting discs to BS 2915 and BS 853 shall be fitted to calorifier shells, and to all hot water storage calorifiers where the primary heating medium is MTHW or HTHW. The rupturing pressure of the bursting disc and the set pressure of the safety valve shall be as indicated.

5.1.5 For BS 853 storage calorifiers where the primary heating medium is MTHW or HTHW, the following shall be included where indicated:

a) An automatic fast response isolating valve, operated by excess secondary pressure, in the primary flow pipework.

b) A check valve in the primary return pipework.

5.1.6 The discharge arrangements from safety valves and bursting discs shall comply with the requirements of Clauses 7.2.3 and 7.2.4.

5.1.7 Heating surfaces shall be formed from copper tubes. Shells of non-storage calorifiers shall be of cast-iron or mild steel. Shells of non-storage calorifiers on DHWS systems shall be galvanised after manufacture, or copper, as indicated.

5.1.8 Shells of storage calorifiers shall be mild steel galvanised after manufacture, mild steel lined with copper, or copper as indicated. Sacrificial anodes shall be provided as indicated.

5.1.9 Where calorifier shells are galvanised the copper tubes shall be tin-coated on the secondary side.

5.1.10 The tube plate and tube chest cover shall be provided with a lifting ring where the flange diameter is 600mm and over. Provision shall be made for easy removal of the heating surface from the body. Sufficient set-bolts shall be provided to enable the tube nest to be withdrawn without breaking the joint between the tube plate and the chest cover plate.

5.1.11 Flange drillings shall be uniform, as far as practicable, to permit interchange of tube assemblies. Spare tube and plate assemblies shall be supplied where indicated.

5.1.12 Horizontal calorifiers shall be supported on brick or concrete piers and/or mild steel cradles. Vertical calorifiers shall be provided with purpose made steel support frames. Sheet lead pads shall be fitted on the bearing surfaces of all copper calorifiers.

5.1.13 On installations of two or more calorifiers each safety vent may be connected into a common vent pipe through a three-way cock (see Clause 7.8.7) so arranged that no calorifier can be isolated simultaneously from the open vent pipe and the free outlet. Vent pipes shall rise continuously and not be obstructed by a valve or any other item.

5.1.14 The secondary side of multiple DHWS storage vessels shall be connected in parallel as indicated. Unless otherwise indicated each vessel shall be independent and complete with isolating valves to permit partial service to be maintained when the isolated vessel is out of service. Isolated sections of pipework shall be provided with drain cocks in accordance with clause 7.12.3.

5.2 CYLINDERS

5.2.1 Direct cylinders shall be as follows:

a) Galvanised mild steel cylinders shall comply with BS 417: Part 2 grade A or grade B, as indicated.

b) Copper cylinders shall comply with BS 699 grade 1 or grade 2, as indicated. Handholes shall be not less than 150mm diameter and shall be provided with covers secured by studs and nuts.

5.2.2 Indirect cylinders shall comply with BS 1566: Part 1 Grade 2. Handholes shall be fitted as detailed in Clause 5.2.Kb).

5.2.3 Cylinders larger than or for a greater working head than those covered by Clauses 5.2.1 and **5.2.2** shall be constructed in accordance with BS 853. Such cylinders/storage calorifiers shall be provided with a manhole of the size and type specified in BS 853 unless a bolted top is fitted. All mild steel indirect cylinders shall be provided with a bolted top. Sacrificial anodes shall be provided as indicated.

5.2.4 Manhole covers shall be secured with studs or bolts and nuts, or with one or more external bridge(s). Joints for handhole and manhole covers shall be made with an approved re-usable jointing material.

5.2.5 Supports for mild steel and copper cylinders shall be as detailed in Clause 5.1.12.

5.2.6 Bubble top calorifiers and cylinders shall comply with BS 853 where applicable.

5.3 ELECTRICALLY HEATED HOT WATER STORAGE VESSELS

5.3.1 Where an electrical immersion heater is fitted into a storage calorifier or cylinder for the supplementary heating of domestic hot water, or where electrical heating is used in any vessel for this purpose, the following items shall be included:

a) A safety valve on the shell, or adjoining pipework immediately adjacent to the shell. The set pressure shall be in accordance with BS 853.

b) An open vent pipe fitted in accordance with Clause 5.1.13.

c) A thermostat acting on the power supply to maintain the water temperature within an adjustable setting between 50°C and 80°C.

d) An independent high limit cut-out device set to isolate the power supply at a water temperature 10°C above the thermostat setting. This device shall be arranged for manual reset.

5.4 PLATE HEAT EXCHANGERS

5.4.1 Plate heat exchangers shall comprise corrugated plates with primary and secondary fluid ports, assembled with ring gaskets and plate seals, mounted on a frame having end-support plates, rack and end posts, and clamped together with long bolts and tube washers acting on loose end pressure plates.

5.4.2 End plates shall carry screwed connections for piping up to DN50 and flanged connections for piping DN65 and above.

5.4.3 Gasket material shall be entirely suitable for the fluids to be used and shall be Water Research Centre approved.

5.4.4 Plates shall be fabricated in Grade 316 stainless steel or other approved material.

5.4.5 The assembly and frame members shall be located on concrete plinths as indicated.

5.5 CISTERNS AND COLD WATER TANKS

5.5.1 Cisterns and cold water storage tanks shall be of the following types as indicated:

a) Welded or riveted mild steel

b) Pressed steel sectional

c) Thermo-plastics for cisterns

d) Glass reinforced plastics (one piece)

e) Glass reinforced plastics (sectional)

f) Aluminium/galvanised steel, lined with a butyl rubber membrane. All potable water storage vessels shall comply with the Water Byelaws.

5.5.2 Mild steel cisterns shall be galvanised type to BS 417: Part 2 Grade A, sacrificial anodes being provided where indicated. Thermo-plastics cisterns shall comply with BS 4213. Pressed steel sectional tanks, glass reinforced plastics and butyl rubber lined cisterns shall be approved by the PM.

5.5.3 Each cistern shall be provided with a loose cover formed in sections not exceeding 2m long and 1m wide. Covers for steel cisterns shall be formed from 1.6mm thick galvanised mild steel with flanged edges to the sections. Covers for plastics and butyl rubber lined cisterns and tanks shall be of the same material as the cistern or tank body. The termination of vent pipes into cisterns and tanks shall permit the easy removal of the covers.

5.5.4 Pressed steel tanks shall be of the externally flanged type and complete with purpose-made covers and all necessary tie rods. Galvanised mild steel cisterns and pressed steel tanks shall be painted internally with two coats of an approved bituminous solution.

5.5.5 Each cistern or tank shall be fitted with a float operated valve as specified in Clause 7.8.8. These valves shall be of the sizes indicated and suited to the pressure available. Cisterns and tanks shall be installed in positions that allow easy access for maintenance.

5.5.6 Warning and/or overflow pipes shall be twice the bore of the ball-float valve fitted or 32mm size, whichever is the greater. Pipes shall be run to discharge outside the building.

5.5.7 Connections to mild steel cisterns and tanks shall be made by means of bosses, screwed flanges or pads and studs. Connections on mild steel cisterns shall be welded before galvanising. Flanges shall comply with the requirements of Section 4. Openings for connections to other tanks may be cut on site and the connections made with back-nuts and plastics washers. For thermo-plastics and butyl rubber lined cisterns and tanks, connections shall be fitted in accordance with the manufacturer's recommendations. Flanged connections may be used on modular glass reinforced plastics tanks and cisterns.

5.5.8 Unless otherwise indicated supports for cisterns and tanks will be provided by the Building Contractor. Where the Building Contractor is responsible for cold-water services he will supply and fit the cold-water storage cistern for domestic and sanitary purposes and will connect the cold-water supply to all ball-float valves.

5.5.9 Cisterns and tanks shall be labelled as indicated on site by the PM.

5.5.10 Multiple cold water storage tanks shall be connected in series complete with by-pass, or parallel as indicated. Unless otherwise indicated each tank shall be independent and complete with isolating valves to permit partial service to be maintained when the isolated tank is being cleaned. Isolated sections of pipework shall be provided with drain cocks in accordance with clause 5.1.14.

5.6 FEED/EXPANSION AND SPILL VESSELS FOR BOILER INSTALLATIONS

5.6.1 These shall be constructed in accordance with the requirements of BS 417: Part 2, BS 1563 or BS 1564, as appropriate. Steel tanks shall be galvanised. Tanks shall be internally and externally finished with corrosion resistant coatings of approved specification. Tank covers shall be close fitting but not air-tight. Floating blankets or other means of preventing water aeration shall be provided as indicated.

5.7 BOILER FEED TANKS (HOTWELLS) FOR STEAM BOILERS

5.7.1 Tanks shall be constructed from Austenitic stainless steel or carbon steel as indicated. Tanks shall be covered but adequately vented. Where indicated, the water temperature in the tank shall be maintained at 80°C by direct steam injection. Carbon steel tanks shall be painted internally to clause 5.5.4. Feed tanks shall be insulated; thermal insulation shall be in accordance with Section 10.

5.8 SLOWDOWN TANKS FOR STEAM BOILERS

5.8.1 Blowdown tanks shall be constructed as pressure vessels to BS 5500 Category 3. Design pressure shall not be less than 25% of the maximum permissible working pressure of the boiler(s), and shall ensure that flash steam is vented safely. Tanks shall be painted internally and externally as Clause 5.5.4.

Section Six—Space Heating Equipment

6.1 RADIATORS

6.1.1 Unless otherwise indicated radiator heating systems shall operate at temperatures not exceeding 95°C. Radiators shall be of the types, ratings and dimensions indicated, and they shall be manufactured and tested in accordance with the requirements of BS EN 442-1. Cast-iron radiators shall be free from scale and sand. Steel radiators shall be fabricated from steel sheet welded at the seams and strengthened by spot welding between waterways; they shall be free from distortion, have pressings which are regular in contour, and be uniform in appearance. The radiator heating surface provided in any room shall be not less than the aggregate indicated. Radiators shall be supplied without feet unless otherwise indicated and be finished with one coat of primer before leaving the works.

6.1.2 The positions and heights above floor of all radiators shall be confirmed with the PM. A minimum clearance of 75mm shall be provided between the floor and the underside of any pipe serving a radiator. The minimum clearance between the floor and the underside of a radiator shall be 150mm. Radiators shall be kept 40mm clear of walls when supporting brackets and stays are built-in, otherwise the clearance shall be in accordance with the manufacturer's standard bracket details. For LTHW installations, radiators shall be provided with valves on the flow and return connections as detailed in Section 7.5. An air vent shall be fitted at the top of each radiator.

6.1.3 Radiators shall be supported on bottom brackets and top stays or purpose-designed brackets to suit the type of radiator; the supports may be of the two-piece adjustable pattern. Where used on masonry walls they may be either built-in or plugged and screwed to the wall face. Where the masonry wall has an internal lightweight structural facing, the radiator supports shall be approved.

6.1.4 Supports for cast-iron and steel panel radiators fixed direct to lightweight partitions shall be approved before installation.

6.1.5 Supports for cast-iron and steel column type radiators against lightweight partitions shall be designed to transmit the weight to the floor and shall be screwed to or built into the floor; top stays shall be approved.

6.1.6 Where radiators are fed by a straight section of pipework which is beneath the radiators and is more than 10m long, the radiator brackets shall be of the suspended pattern or other approved type designed to permit free movement due to expansion and contraction of the pipework. (Pipe sets of under 225mm shall be deemed straight pipework).

6.1.7 Cast-iron column radiators up to 20 sections long shall have two bottom brackets and one top stay. Radiators more than 20 sections long shall have an additional bottom bracket and top stay for each increment of up to 20 sections in length. Steel column radiators shall be supported in accordance with manufacturer's recommendations.

6.1.8 Cast-iron panel radiators up to 1.5m long shall have two top and two bottom brackets. An extra pair of brackets shall be provided for each increment of up to 1.5m in length. Steel panel radiators shall be supported in accordance with manufacturer's recommendations.

6.1.9 Where radiators with feet are specified and the floor finish is of a material likely to be damaged, the radiators shall stand on 12mm thick hardwood boards supplied by the Building Contractor.

6.1.10 The Contract shall include taking down radiators once after initial installation for painting and for re-fixing.

6.1.11 Existing radiators to be disconnected and re-fixed in the same or new positions shall be thoroughly washed out, wire brushed and re-painted as necessary.

6.2 CONVECTORS

6.2.1 Convectors shall be of the types, ratings and dimensions indicated. For natural convectors the manufacturer's declared ratings shall have been obtained from tests in accordance with BS EN 442-1. For fan convectors the manufacturer's declared ratings shall have been obtained from tests in accordance with BS 4856: Part 1.

6.2.2 Unless otherwise indicated heater elements shall be enclosed in casings purpose-made by the convector manufacturer. The casings shall have air inlet openings at the bottom and outlet grilles fitted with internal dampers operated by lever or knob on the outside of the casing. The casings shall be of mild steel sheet not thinner than 1.25mm suitably stiffened, with removable front panels secured with permanent fixings or captive screws. The casings shall be free from rough edges and shall be treated with a rust inhibitor and finished with stove primer.

6.2.3 The elements shall be of copper or bronze tubes fixed securely to the flow and return headers with non-ferrous fins not thinner than 1mm unribbed (0.2mm ribbed) bonded to the tubes. The fins shall be free from sharp edges and corners. Copper tubes shall meet the test requirements of BS 2871 Part 3.

6.2.4 The positions and heights above floor of convectors shall be agreed with the PM. Where recessed or built-in convectors have been specified, the Contractor shall supply full details of the openings and of any fixings or framing required.

6.2.5 Wall-mounted convectors shall be secured by screws or bolts passing through holes in the back plate or frame of the unit, and a resilient gasket shall be inserted between the edges of the back panel and the finishes at the sides and top. A minimum clearance of 75mm shall be provided between floor and any pipe serving a wall-mounted convector. Two supports shall be provided for each wall-mounted convector not exceeding 1.25m long and three supports for each convector longer than 1.25m.

6.2.6 Convectors for LTHW and MTHW systems shall be provided with air cocks accessible from the front or side without dismantling the casings. The discharges from air cocks on MTHW convectors shall be arranged to ensure no risk of injury to operatives.

6.2.7 Convectors on LTHW and MTHW systems shall be provided with union valves having heat insulated handwheels on the flow connections, and union valves with lock-shields on the return connections.

6.2.8 Steam and HTHW convectors shall be fitted with valves and equipment in accordance with Section 6.6.

6.2.9 The motor controllers for fan convectors shall be integral with the convector casings, and motors shall be resiliently mounted. The noise levels resulting from their operation shall not exceed the Noise Ratings as indicated.

6.2.10 Air filters for fan convectors shall be of the open-cell plastics cleanable type and easily removable. They shall have an average arrestance of not less than 80% in accordance with BS EN 779 : 1992.

6.2.11 Gas-fired convector heaters shall be as indicated.

6.3 CONTINUOUS PERIMETER HEATING

6.3.1 Perimeter heaters for LTHW heating shall be of cast-iron or steel, radiant or combined radiant/ convection types, or steel-encased finned-tube convection type.

For MTHW they shall be steel-encased finned-tube convection type.

Units shall be of the rating and dimensions indicated. The manufacturer's declared ratings shall have been obtained from tests in accordance with BS EN 442-1.

6.3.2 Heaters shall be complete with all ancillary items such as internal and external cover strips, dummy sections, valve boxes etc so that each run presents a continuous unbroken appearance. Where indicated the casings shall incorporate provision for accommodating other services. Additionally, control dampers and sound baffles between rooms shall be provided where indicated. The positions, lengths and heights of the heaters shall be agreed with the PM.

6.3.3 A gasket as specified in Clause 6.2.5 shall be provided at the back of each heater.

6.3.4 Finned-tube convection type heaters shall have removable front plates to provide access for cleaning. The elements for LTHW shall be as specified in Clause 6.2.3. For MTHW the elements shall be steel pipework with steel fins.

6.3.5 Copper connecting pipework between the elements of continuous perimeter convectors for LTHW shall have capillary or compression joints to suit the finned elements. The copper tube shall be of the same grade and diameter as the element tube.

6.3.6 Expansion devices and guides as detailed in Section 4 shall be fitted into the connecting pipe as required.

6.3.7 Perimeter heaters on LTHW and MTHW systems shall be provided with air cocks in accordance with Clause 6.2.6, and valves in accordance with Clause 6.2.7.

6.4 RADIANT PANELS, STRIPS, CEILINGS AND FLOORS

6.4.1 Radiant panels and strips shall be of the ratings and dimensions indicated. The ratings shall have been obtained from type tests. For LTHW and MTHW systems radiant panels shall have mild steel or cast-iron grid-type waterways (free from scale and sand). The waterways shall be shaped to provide a surface affording intimate contact with steel plates of not less than 2mm thick secured to present a continuous face. Alternatively, the waterways may be formed from mild steel tube welded continuously to the surface plate. For LTHW systems, copper tube waterways (with aluminium or steel face plates) will be acceptable.

6.4.2 For steam and HTHW systems the steam or waterways shall be of mild steel tube, complying with BS 1387 'Heavy', welded to the surface plate which shall be not less than 2mm thick.

6.4.3 Surface plates shall be smooth and free from distortion. Where connections pass through the sides of a panel they shall be sealed effectively. The space between the edges of a panel and the wall or ceiling surface to which the panel is to be attached shall be completely sealed.

6.4.4 Radiant strips shall have rigid face plates of aluminium or mild steel not less than 1mm thick, secured to single or multiple waterways of mild steel tube in such a manner as to provide adequate heat transmission to the face plate. Tubes for steam or HTHW systems shall be of mild steel complying with BS 1387 'Heavy', with welded joints. Each radiant strip shall be assembled in a continuous unbroken length.

6.4.5 Radiant panels and strips shall be arranged horizontally, vertically or inclined, as indicated, and suspended from purpose-designed hangers, the points of support being in accordance with the maker's recommendations. Where arranged horizontally they shall be installed with a fall of not less than 1 in 200.

6.4.6 Where radiant panels or strips are to be fixed to walls or ceilings, or are suspended to provide radiation from one side only, thermal insulation having a transmittance not greater than 1.4W/m^2K shall be incorporated between the face plate and a back cover plate, or fixed securely to the back face of the radiant surface.

6.4.7 For LTHW and MTHW systems flush type air vents shall be fitted at the highest point of panels mounted on walls. Panels supported on ceilings shall be arranged to vent air through the connecting pipework. Panels and strips for LTHW and MTHW systems shall have union valves with heat insulated hand-wheels on flow connections and union valves with lock-shields on the return connections. Steam and HTHW radiant panels and strips shall be fitted with valves and equipment in accordance with Section 6.6.

6.4.8 Radiant/convective ceilings or floors shall be as indicated.

6.4.9 Gas-fired radiant heaters, either individual units or purpose-designed integral systems shall be as indicated.

6.5 UNIT HEATERS

6.5.1 The rated capacity and operating conditions of unit heaters shall be as indicated. The manufacturer's declared ratings shall have been obtained from tests in accordance with BS 4856: Part 1.

6.5.2 Unit heaters shall have adjustable self-locking louvres. The casings shall be of sheet metal. Heater batteries shall be of the following types:

a) Copper tubes with non-ferrous gills or fins, fitted into copper or bronze headers;

b) Copper tubes with non-ferrous gills or fins, fitted into steel headers;

c) Mild steel tubes with mild steel gills or fins, fitted into welded steel headers, the whole suitably protected against corrosion. The method of protection shall be approved by the PM

6.5.3 Copper tubes specified in Clause 6.5.2 shall meet the test requirements of BS 2871: Part 3.

6.5.4 The gills or fins shall be bonded to the tubes. Ample provision shall be made for expansion of the heater battery within the casing.

6.5.5 Fan impellers shall be of robust construction, balanced statically and dynamically, and attached to obviate any risk of detachment while the fan is

running. Fan guards shall be fitted. The noise levels resulting from their operation shall not exceed the Noise Ratings indicated.

6.5.6 The discharge air temperature shall not exceed 50°C.

6.5.7 Motors shall be mounted resiliently on the heater casings on rubber or other approved anti-vibration material.

6.5.8 The type and method of automatic control of the unit heaters shall be as indicated.

6.5.9 Heaters shall be provided with two or more points of suspension and shall be so suspended that their direction of discharge can be altered.

6.5.10 Heaters shall be designed and positioned to permit easy cleaning and dismantling.

6.5.11 Unit heaters on LTHW and MTHW systems shall be provided with union valves having heat-insulated handwheels on the flow connections, and union valves with lock-shields on the return connections. Steam and HTHW unit heaters shall be fitted with valves and equipment in accordance with Section 6.6.

6.6 EQUIPMENT FOR STEAM AND HTHW HEATING APPLIANCES

6.6.1 Each heating appliance on a steam system shall be provided with a globe valve on the inlet connection complying with Clauses 7.10.3 and 7.10.5. The outlet connection shall be provided with a strainer, check valve and steam trap set together with a globe or fullway valve as indicated. Dirt or scale pockets and sight glasses shall be installed where indicated.

6.6.2 The flow and return connections to each heating appliance on an HTHW system shall be provided with valves complying with Clauses 7.8.3 and 7.9.3.

6.7 SURFACE TEMPERATURES

6.7.1 Where space heating equipment is located within 2 metres of floor level, (or is otherwise normally accessible by occupants), the equipment shall be protected by approved screens where surface temperatures exceed 95°C.

Section Seven—Valves, Taps and Cocks

7.1 GENERAL

7.1.1 Unless otherwise indicated copper alloy shall mean one of the alloys listed in BS 5154 suiting the particular application.

7.1.2 Gland packing, plug lubricants etc. shall be suitable for the application. For potable water systems, materials shall comply with the requirements of the Water Company. Exfoliated graphite packing shall not be used when in contact with steel components.

7.1.3 Valves shall be easily accessible. Valves fitted in horizontal pipework or to equipment with horizontal connections, shall be installed with the valve spindle vertically upwards unless otherwise agreed by the PM. Check valves shall be installed in accordance with the manufacturer's recommendations.

7.1.4 Where indicated, valves or cocks shall be lockable, with purpose-made locking devices which do not impede the fast closure of the valve where that is necessary. The locking device shall remain attached to the valve in both open and closed position. Valving to boilers flow and return connections shall be to clauses 30.1 and 30.2 of BS 759: Part 1. Where the additional valves are installed and are separated by a length of pipe, this length shall have a drain cock and air vent.

7.1.5 Where modifications or extensions to existing services are to be carried out, all valves which are to be removed and re-fixed shall be overhauled thoroughly, with glands and seals renewed, all to the satisfaction of the PM.

7.1.6 Copper alloy valves for mains water and HWS systems shall be resistant to dezincification.

7.1.7 Valves for the services in this Specification shall be in accordance with Table 7A and as indicated in Schedule 1.

7.2 SAFETY AND RELIEF VALVES

7.2.1 Safety and relief valves shall meet the requirements of the appropriate BS for the boiler, calorifier or pressure equipment to which they are connected, and they shall be suitable for the operating conditions of the system. They shall be of the totally enclosed spring-loaded type with padlock.

7.2.2 Safety and relief valves in LTHW and steam installations shall have discharge connections of sizes as indicated. Where any low point occurs in the discharge pipework it shall be fitted with a DN15 waste pipe carried clear of the insulation for drainage.

7.2.3 In MTHW and HTHW installations the safety and relief valve discharge connections and discharge arrangements shall not impede safe two-phase discharge at the intended rate.

7.2.4 Safety and discharge pipework for hot water systems shall be laid with a continuous downward gradient.

7.2.5 Discharge and waste pipes shall terminate at visible and safe positions to be agreed with the PM. Connections to drains shall be provided as indicated.

7.3 PRESSURE REDUCING VALVES

7.3.1 Valves shall be of the following types:

a) Valves for reducing the steam pressure to apparatus not designed to withstand the maximum pressure of the high-pressure line shall be of an approved spring-loaded pilot-operated type.

b) Where apparatus on the low-pressure side is capable of withstanding the maximum pressure of the high-pressure line, valves may be of the single-seated spring-loaded diaphragm type.

c) Bodies of valves up to and including DN50 shall be of bronze or nodular iron, as indicated, and have threaded end connections to BS 21. Valves DN65 and over shall have bodies of steel or nodular iron to BS 2789, as indicated, with end connections flanged to BS 4504: Part 3 or BS 1560. Valve seats and discs shall be of nickel-alloy or stainless steel and shall be renewable. Each valve shall be capable of maintaining a reduced outlet gauge pressure within 35mbar of the set pressure and shall be installed with an excess pressure protection valve or safety valve on the low-pressure side.

7.3.2 Each reducing valve shall be installed with an isolating valve and strainer or separator as relevant and, where indicated, a pressure gauge on the high-pressure side. The strainer shall include a stainless steel screen on mesh size as recommended by the reducing valve manufacturer. A pressure gauge shall be fitted on the downstream side of safety valves or excess pressure protection valves. Pressure gauges shall be mounted on mild steel syphons with bronze isolating cocks.

7.4 THERMOSTATIC CONTROL VALVES

7.4.1 Valves fitted to appliances other than radiators, shall have bodies of gunmetal, bronze, cast-iron or steel as indicated. The provision of either threaded or flanged end connections shall be in accordance with the requirements for valves in Clauses 7.8.1 to 7.10.7 as appropriate.

7.5 LTHW RADIATOR VALVES

7.5.1 Radiator isolating and flow control valves shall be threaded by BS 21 with union nut and tail piece. Valves shall be of the following types as indicated:

a) Isolating valves operated by a handwheel of heat insulating material. Such handwheels may be either shaped to enclose the valve stem and gland, or comprise a handwheel and separate easy clean gland shield.

b) Valves for flow regulation and setting operated by a loose key. Easy clean shields or enclosures shall match the handwheel appearance. Two loose keys shall be provided for each size of spindle.

c) Thermostatically controlled valves. These shall be of a type approved by the PM.

7.6 REGULATING VALVES

7.6.1 Regulating or double regulating valves shall have proportional characterised plugs to give a linear or equal percentage characteristic and micrometer indicators or indicators of the type where *a* pointer moves over a scale permanently fixed to the main structure of the valve.

7.6.2 Double regulating valves shall incorporate a facility to prevent valves being opened beyond preset limits.

7.6.3 Valve body material and type of end connections shall be in accordance with the requirements of Clause 7.8 as relevant.

7.6.4 Regulating and double regulating valves shall be sized for the correct pressure drops, as indicated, to obtain adequate valve authority.

7.7 SYSTEM COMMISSIONING VALVE SETS

7.7.1 Measuring devices shall provide flow measurement accuracy to within + 5% under the service conditions to be expected. Measuring devices shall be selected for particular application such that the differential pressure produced is consistent with achieving measurement accuracy.

7.7.2 Commissioning sets for balancing the water flows between the circuits in LTHW, MTHW and HTHW heating systems shall comprise the following as indicated:

a) Measuring devices comprising oblique globe valves, calibrated for use in the fully open position, shall be installed at the upstream ends of circuits, with regulating devices at the downstream ends.

b) Fixed orifice plates to BS 1042 and isolating valves installed at the upstream ends of circuits, with regulating devices at the downstream ends.

c) Combined or integral measuring/regulating devices comprising fixed orifice plates coupled to regulating devices installed at the downstream ends of the circuits and isolating valves at the upstream ends.

7.7.3 Pressure test fittings shall enable safe, positive quick-coupling and uncoupling of the flexible connections from the differential pressure indicators.

On MTHW and HTHW installations the quick-coupling pressure test fittings shall be protected by manual isolating valves of appropriate quality, irrespective of whether the test fitting has an integral safety feature.

7.7.4 Regulating devices shall be double regulating valves selected for particular application such that required flow rates are achieved with valve positions more than 25% open.

7.8 LTHW AND MTHW HEATING SYSTEMS

7.8.1 Bodies of valves and cocks up to and including DN50 shall be copper alloy. Bodies of valves and cocks DN65 and larger shall be copper alloy or cast-iron as indicated.

7.8.2 Valves and cocks in steel pipework up to and including DN50 shall have threaded ends and those of DN65 and above shall have flanged ends.

7.8.3 Isolating valves on flow connections to equipment shall be fitted with heat insulated handwheels, and valves on return connections shall be double regulating valves.

7.8.4 Butterfly, ball and plug valves shall be operated either directly or indirectly as indicated.

7.8.5 Air cocks shall be threaded nickel or chromium plated of the spoutless pattern. One loose key shall be provided for each ten air cocks plus one spare.

7.8.6 Three way cocks shall have the position of the ports clearly engraved on the square end of the plug. Each cock shall be provided with a loose key.

7.8.7 Float operated valves shall be a size and type to suit the cistern and duty and those for use with feed/expansion and spill tanks shall be of the long-arm type arranged to shut off where the tank contains 150mm depth of water. Where a water meter, measuring the make-up quantity is indicated, the float-operated valve shall be of the delayed action type. Valve floats shall be heavy copper or may be heavy plastics for cold water cisterns.

7.8.8 Check valves shall be as indicated.

7.8.9 Valves for MTHW systems shall include the following features as indicated:

a) Renewable seats, plugs or discs.

b) Seating devices to isolate the stuffing box from back pressure when the valve is open.

7.9 HTHW HEATING SYSTEMS

7.9.1 Bodies of valves and cocks up to and including DN50 shall be bronze, gunmetal, spheroidal graphite iron or steel as indicated. Bodies of valves and cocks DN65 and larger shall be steel or spheroidal graphite iron. All valves shall be flanged.

7.9.2 Valves on flow and return connections to appliances shall comply with the requirements in Clause 7.8.3. Other valves and cocks shall comply with the requirements of Clause 7.8.10 as appropriate except that renewable seats, plugs or discs shall be stainless steel or nickel alloy.

7.9.3 Ball and plug valves shall be operated either directly or indirectly as indicated.

7.9.4 Check valves shall be as indicated.

7.9.5 Valves with packless glands or bellows seals shall be used where indicated.

7.10 STEAM SYSTEMS

7.10.1 Bodies of valves and cocks up to and including DN50 shall be copper alloy or steel as indicated. End connections shall be threaded. Isolating valves shall be globe type.

7.10.2 Bodies of valves and cocks DN65 and larger shall be of steel or spheroidal graphite iron. End connections shall be flanged.

7.10.3 Valves on the inlet connections to appliances shall be fitted with heat insulated handwheels.

7.10.4 'Rapid action' valves shall be used for automatic intermittent blow-down systems from steam boilers. They shall be arranged to fail safe.

7.10.5 Outside plant rooms, steel gate (flexible wedge) valves may be used.

7.10.6 Check valves shall be as indicated.

7.10.7 Valves shall comply with the requirements of Clauses 7.8.10 and 7.9.6.

7.11 CONDENSATE SYSTEMS

7.11.1 Bodies of valves and cocks up to and including DN50 shall be of copper alloy. End connections shall be threaded when used in steel pipework, or compression type when used in copper pipework.

7.11.2 Bodies of valves and cocks DN65 and larger shall be of cast-iron or copper alloy to match the pipework. End connections shall be flanged.

7.11.3 Valves used for isolating shall be as indicated.

7.11.4 Check valves shall be as indicated.

7.12 DHWS AND COLD WATER SUPPLY SYSTEMS

7.12.1 Check and anti-vacuum valves to BS 6282 shall be provided as required by the Water Company.

7.12.2 Stop valves shall be in accordance with Table 7A and Clause 1.5.6. Where approved by the PM, copper alloy gate valves and proprietary servicing valves (approved by the local Water Company) may be used for isolating single outlet fittings and appliances. Valves with loose jumpers shall not be fitted.

7.12.3 Where indicated, drain cocks shall be provided adjacent to isolating valves to prevent stagnant water being retained in isolated sections of pipework.

7.12.4 Unless otherwise indicated pillar, spray or bib taps and sanitary fittings will be supplied and fitted under separate contract. Where a cold water service installation is included in this Contract, the Contractor shall provide copper or polyethylene tube connections to draw-off points, as indicated.

7.12.5 Urinal cistern inlets shall be controlled by solenoid operated valves serving one or more cisterns as indicated. These valves shall be actuated by means of mains operated clocks arranged to ensure that all cisterns flush at least once per day except at weekends or other fixed periods as indicated. Flow rates to individual urinal cisterns shall be regulated by pet-cocks or disc fittings.

7.12.6 Where sanitary appliances are to be provided with spray taps, a strainer shall be provided immediately after the stop valves on the hot and cold water connections adjacent to the fittings or ranges of fittings. The strainer shall include a stainless steel screen of mesh size as recommended by the spray tap manufacturer.

7.12.7 Stop valves and drinking water taps shall be labelled as indicated on site by the PM.

7.13 NATURAL GAS SERVICES

7.13.1 The installation of valves and cocks shall be as indicated and comply with the recommendations contained in IGE Utilization Procedures IGE/UP/2.

7.13.2 Copper alloy plug cocks shall be provided for copper pipework systems and for steel pipework systems up to and including DN40. In larger sizes on steel pipework full-way cast-iron valves shall be used.

7.13.3 For steel pipework, valves and cocks up to and including DN50 shall have threaded ends and for larger sizes they shall be flanged.

7.13.4 For copper pipework copper alloy plug cocks shall have end connections to suit capillary or compression fittings to BS 864: Part 2 or to BS 2051: Part 1 for existing work.

7.13.5 Valves and cocks for polyethylene pipework shall have end connections to suit fittings to BGC Standard Specification BGC/PS/PL2 Part 2 or BGC/PS/PL3.

7.13.6 Valves buried in structures or externally underground shall be cast-iron.

7.13.7 Union valves or cocks shall be fitted on the outlet sides of primary meters and at the outlet sides of secondary meters. A valve or cock shall be fixed on each branch to an appliance.

7.13.8 Valves relying upon a metal to metal seat and service pressure for isolation purposes shall be only as listed approved by BGC for the particular application.

7.13.9 Each gas appliance shall be fitted with a suitable pressure governor and safety controls appropriate to the duty.

7.14 LPG VAPOUR DISTRIBUTION SYSTEMS

7.14.1 Valves fitted to tanks and manifolds, where the gas vapour is at tank pressure, shall be ball valves having carbon steel bodies, stainless steel balls, and PTFE seals and seats. End connections shall be flanged. There shall be electrical continuity between all metal parts of the valve.

7.14.2 Distribution pipework valves shall be copper alloy ball valves for tight shut-off and of pattern tested and certified by British Gas, with quarter-turn operation. End connections shall be threaded to BS 21.

7.14.3 In laboratories and similar establishments, where portable equipment is to be connected to the distribution pipework by flexible hoses, each supply point shall be fitted with a spring-loaded tapered plug cock intended for LPG, which clearly indicates whether it is in the open or closed position.

7.15 OIL FUEL SERVICES

7.15.1 For oil fuel valves see Table 7A. Drain valves shall be of gunmetal or steel only.

7.16 FIRE PROTECTION SYSTEMS

7.16.1 For landing valves on wet and dry rising mains see Table 7A.

7.16.2 For sprinkler systems stop valves and back pressure valves see Table 7A.

7.16.3 Fire protection systems shall be approved by the Fire Fighting Authority and Water Company as necessary.

7.17 VALVE LABELLING

7.17.1 Plant room valves and every circuit control valve shall be provided with a brass or approved plastics label about 75 x 50 x 1.5mm thick, as BS MA5, stamped or engraved with a reference number. A brief title indicating the valve duty shall be included on the label except where a valve chart is provided in the room where the valve is installed. Wherever practicable the labels shall be affixed to the adjacent structure in a prominent position to identify the valve concerned. Elsewhere a purpose-made light-weight steel bracket for carrying the label shall be welded to the pipework adjacent to the valve.

7.17.2 Schematic circuit control diagrams of the systems shall be fixed in a position approved by the PM. Diagrams shall indicate the position, function, size and reference number of all valves. Diagrams shall be durable, non-fading, and rigidly mounted with an unbreakable washable finish.

TABLE 7A SELECTION TABLE FOR VALVES AND COCKS

Service	Size (DN) (Limitation)	Valve Details — Type	Application	BS No.
LTHW& MTHW	65 & above	Cast iron globe	Isolating	5152
	None	Copper alloy globe	Isolating	5154
	65 & above	Cast iron wedge gate	Isolating	5150
	None	Copper alloy gate	Isolating	5154
	65 & above	Cast iron gate (parallel slide)	Isolating	5151
	65 & above	Cast iron butterfly	Isolating	5155
	65 & above	Cast iron ball	Isolating	5159
	65 & above	Cast iron lubricated plug cock	Isolating	5158
	None	Cast iron check	Non-return	5153
	None	Copper alloy check	Non-return	5154
	None	Cast iron oblique or gate	Regulation	5152
	None	Copper alloy	Regulation	5154
	None	Copper alloy	Regulation	7350
	None	Commissioning sets (with integral fixed orifice ring)	Measurement	7350 5154 5152
	None	Radiator-manual control		2767
	None	Radiator-thermostatic control		7556
	None	Ball float Floats: copper Class C heavy plastics	Level control	1212 1968 2456

TABLE 7A SELECTION TABLE FOR VALVES AND COCKS

Service	Size (DIM) (Limitation)	Valve Details — Type	Application	BS No.
HTHW	None	Steel globe	Isolating	1873
	None	Steel globe	Isolating	5160
	None	Steel globe	Isolating	5352
	Up to 50	Gunmetal globe	Isolating	5154
	None	Steel gate (flexible wedge)	Isolating	1414
	None	Carbon steel ball	Isolating	5159 5351
	None	Carbon steel lubricated plug cock	Isolating	5158 5353
	None	Carbon steel butterfly	Isolating	5155
	None	Steel gate (parallel side)	Isolating	5157
	None	Spheroidal graphite iron globe	Isolating	5152
	None	Steel check (lift pattern)	Non-return	5160 5352
	None	Steel check (swing pattern)	Non-return	1868
	Up to 50	Gunmetal check	Non-return	5154
	None	Cast iron oblique	Regulation	5152
	None	Copper alloy	Regulation	5154
Steam	Up to 50	Gunmetal globe	Isolating	5154
	None	Steel globe	Isolating	1873
	None	Steel globe	Isolating	5160
	None	Steel gate (parallel slide)	Isolating	5157
	None	Steel gate (flexible wedge)—outside plantrooms	Isolating	1414
	None	Spheroidal graphite iron globe	Isolating	5152
	None	Steel check (swing pattern.)	Non-return	1868
	None	Gunmetal check (swing pattern.)	Non-return	5154

TABLE 7A SELECTION TABLE FOR VALVES AND COCKS

Service	Size (DN) (Limitation)	Valve Details — Type	Application	BS No.
Condense	None	Copper alloy gate	Isolating	5154
	65 & above	Cast iron gate	Isolating	5150
	None	Steel ball	Isolating	5159
	None	Steel ball	Isolating	5351
	None	Copper alloy	Regulation	7350
	None	Cast iron check	Non-return	5153
	None	Copper alloy check	Non-return	5154
DHWS & CWS	None	Check and anti-vacuum (as required by Water company)		6282
	None	Stop valves as required by Water Company	Isolating	1010 (Pt.2) 2580 5433 5163
	None	Cast iron gate	Isolating	5150
	None	Cast iron gate (parallel slide)	Isolating	5151
	None	Copper alloy gate	Isolating	5154
	None	Cast iron lubricated plug cock	Isolating	5158
	None	Cast iron butterfly	Isolating	5155
Oil Fuel	None	Fuel services	Isolating	799 (Pts 3,4)
Natural Gas	None	Copper alloy plug cock Copper alloy Cast iron plug valve Cast iron ball Cast iron (parallel slide) Cast iron wedge gate Cast iron globe	Isolating Regulation only	1552 5154 5158 5159 5151 5150 5152
Fire Service	None	Landing valve Stop valve Back pressure valve		5306 (Pt.1) 5306 (Pt.2) Do.
Liquid petroleum gas	None 2"	Carbon steel ball (stainless steel ball) Copper alloy ball- quarter turn operation	Isolating Isolating	5159
Steam and Hot Water	None	Safety and pressure relief		6759 (Pt.1)

TABLE 7A SELECTION TABLE FOR VALVES AND COCKS

Service	Size (DN) (Limitation)	Valve Details — Type	Application	BS No.
Comp. Air & inert gas	None	Safety and pressure relief		6759 (Pt.2)
Process fluids	None	Safety and pressure relief		6759 (Pt.3)

Note: All copper alloy items shall be dezincification resistant

Section Eight—Automatic Controls, Controllers, Cubicles and Panels

8.1 GENERAL

8.1.1 Unless otherwise agreed by the PM the Contractor shall arrange for the automatic controls manufacturer or specialist to supervise the installation, commission all systems, and provide the related As Installed Drawings.

8.1.2 Control systems shall be provided complete with manuals giving full setting up instructions, fault finding and locating information. Simple operating and adjusting instructions shall be recorded permanently inside the lid or cover of each unit where appropriate.

8.1.3 Controls shall be electric, electronic, pneumatic or self acting as indicated. The term 'motorised' is not meant to imply that only electrical controls are acceptable.

8.1.4 Electrical connections between internal components shall be soldered but units and individual items such as clocks shall preferably be of the plug-in type with contacts of not less than 10 ampere rating.

8.1.5 Controls shall conform with the requirements of the Building Regulations.

8.1.6 The control systems shall be compatible with the Building Energy Management Systems provided as indicated.

8.2 SPACE HEATING AND DOMESTIC HOT WATER CONTROL

8.2.1 Primary Temperature Control

Control Systems

8.2.1.1 The water flow temperatures in the heating systems shall be controlled by the following systems as indicated:

a) On/off control;

b) Modulating control;

c) Weather-compensated control.

On/off Control

8.2.1.2 On/off control shall be achieved by means of thermostats mounted in the positions indicated, controlling 2 or 3 port motorised control valves, circulating pumps, boiler firing equipment, fans or any other similar type of plant as indicated.

Modulating Control

8.2.1.3 Modulating control shall be achieved by means of temperature detectors mounted in the positions indicated, controlling two or three port motorised control valves via a proportional, or proportional plus integral controller as indicated.

Weather-Compensated Control

8.2.1.4 Weather-compensated control shall be achieved by a blending arrangement or by modulating the primary flow to a heat exchanger as indicated.

8.2.1.5 These systems shall comprise outside air temperature detectors fixed in the positions indicated and operated in conjunction with water temperature detectors in the relevant heating flow mains. Controllers shall automatically adjust the flow water temperatures, as determined by the outside temperature, via three port or two port control valves as indicated. Manual adjustment of the control schedule shall be provided independently at light and heavy load settings.

8.2.1.6 Provision for control schedule reset from internal temperature detectors shall be included.

8.2.2 Time Programme Control

Control Methods

8.2.2.1 Time control of the heating systems shall be by the following methods as indicated:

a) On/off time-clock control;

b) Optimum Start Control and Optimum Off Control.

8.2.2.2 Daily and weekly programme facilities shall be adjustable to suit the plant and building response.

8.2.2.3 Facilities shall be provided to allow pumps to run on after boilers are switched off to allow for heat dissipation. (See Section 2.10.3).

8.2.2.4 Where indicated a programmable facility shall be provided to allow extensions or reductions to any daily heating period and deletions for holidays.

8.2.2.5 Unless otherwise indicated:

a) Controllers shall be programmable to provide two independent heating periods during any part of a 24 hour period.

b) Clocks shall be driven by synchronous motors or electronic timers with a self maintaining or electrical reserve of not less than 72 hours.

c) Clocks shall incorporate facilities for omitting days on a seven day programme.

d) Frost and condensation protection for the buildings shall be provided and monitored by external and internal temperature detectors respectively during 'heating-off periods. The external detectors shall control the heating pumps and the internal detectors shall control the heat sources.

On/Off Time Control

8.2.2.6 Where indicated clocks used on weather-compensated circuits shall be provided with additional contacts to provide a boost to reduce the buildings pre-heat period. Boost shall be achieved by fully opening the compensated circuit mixing valve unless otherwise indicated. Boost termination shall be activated when internal temperature reaches set-point.

Optimum Start Control

8.2.2.7 These controllers shall provide optimum start of heating plant taking into account the thermal capacity and response of the buildings, and the external and internal temperatures as appropriate. They shall provide boost during building pre-heat periods and early start facilities after prolonged shutdown of plant. Boost termination shall be activated by the internal temperature detectors.

8.2.2.8 Unless otherwise indicated:

a) External temperature detectors shall be mounted on the north sides of buildings at roof level and be shielded from direct solar radiation. The detectors shall be sensitive to night sky radiation and shall be capable of measuring external air temperature independently of wind direction.

b) Internal temperature detectors shall be located in representative rooms having thermal performances typical of the buildings or zones to be controlled or as indicated.

Optimum Start and Optimum Off Control

8.2.2.9 Where indicated optimum start controllers shall be provided with optimum off facilities, which override the day controls when there is sufficient residual heat for the buildings not to drop below a minimum temperature by the end of the working day. They shall control the heat sources, circulating pumps and control valves as appropriate.

8.2.2.10 The set point for the minimum temperature at the end of the working day shall be adjustable.

8.2.3 Space Temperature Control

Control Systems

8.2.3.1 Internal temperature control shall be provided by one of the following systems as indicated:

a) On/off control;

b) Modulating control;

c) Thermostatic radiator valves;

d) Weather-compensated control with internal correction.

On/Off and Modulating Control

8.2.3.2 This shall be achieved by the use of space thermostats mounted in the positions indicated controlling 2 or 3 port motorised valves as indicated.

Weather-Compensated Control with Internal Correction

8.2.3.3 Weather-compensated control with internal correction shall be achieved by the use of space thermostats mounted in the positions indicated arranged to modify the weather-compensated control schedule dependent on internal temperature.

8.2.3.4 Set point internal temperature shall be adjustable. The influence of internal temperature variation on the control schedule shall be adjustable.

8.2.4 Room Thermostats and Temperature Detectors

8.2.4.1 Room thermostats for space heating temperature control shall comply with relevant parts of BS EN 60730, 60738 and 61058.

8.2.4.2 Adjustable thermostats shall be provided where indicated. A clearly visible indicator and calibrated numerical scale clearly marked in °C shall be provided for temperature adjustment without the use of tools. Covers shall prevent unauthorised tampering with the temperature settings.

8.2.4.3 Non-adjustable thermostats shall be provided where indicated. They shall have no external means for changing the switching temperature.

8.2.4.4 Room thermostats passing a load current of less than 12 amps through their contacts during normal operation shall be fitted with shunt connected accelerator heaters across the supply.

8.2.4.5 Where the load current exceeds the rating of the thermostat contacts, separate contactors shall be provided.

8.2.4.6 Room thermostats and temperature detectors shall be mounted in a position representative of the zone or space heated by the emitting system or appliance to be controlled. Items shall not be mounted on external walls, indirect sunlight, draughts or be subject to heating from any other equipment. Wall mounting height shall be 1.5 metres from the floor.

8.2.5 Heating Calorifiers

8.2.5.1 Control of secondary heating systems shall be as listed in Clause 8.2.3.1.1.

8.2.5.2 Modulating control of heating calorifiers with primary media of MTHW, HTHW or steam shall be to the dictates of secondary flow temperature sensors via proportional plus integral controllers, or self-actuated valve systems as indicated.

8.2.5.3 Steam control shall be by means of tight shut-off modulating valves in the steam connections. Sensing elements shall be capable of withstanding the highest temperatures the systems will attain.

8.2.5.4 Primary hot water control shall be by three port mixing valves in diverting application positioned in the primary returns. The valves shall be electric, pneumatic or self acting. Electrically operated valves shall be fitted with a spring return, or other means to close the valve to service, in the event of a local power failure, and automatically return the system to normal operation on power resumption. Control valves shall be provided with means of isolation at each port. Sensing elements shall be suitable for the highest system temperature.

8.2.5.5 Calorifiers where the maximum secondary operating temperature is less than that of the primary system shall have high limit temperature controls comprising automatically operated isolating valves installed in the primary flow connections controlled by limit thermostats installed in the calorifier bodies or in the secondary flow connections before any valves. The valves shall be arranged to be open under normal operating conditions. In the event of abnormally high secondary temperature the control shall close the valve and lock out, requiring manual reset. In the event of power failure the valve shall close and reopen automatically upon restoration of supply—if the control will allow it.

8.2.6 Combined Heating and DHWS System

8.2.6.1 Control of secondary heating systems shall be as detailed in Clause 8.2.3.1.1.

8.2.6.2 DHWS storage calorifiers shall be provided with on/off type controls with sensors fitted in the calorifier shells.

8.2.6.3 Storage calorifiers shall be fitted with the limit controls specified in Clause 8.2.5.5.

8.2.7 DHWS Systems

8.2.7.1 External contact thermostats and temperature indicators shall not be installed without prior approval.

8.2.7.2 The control of single storage vessel DHWS systems supplied from separate automatically-fired DHWS boiler(s) shall be by means of immersion type thermostats in the storage vessels, wired in series with the boiler control thermostat(s) and arranged to start and stop the boiler(s) at pre-set temperatures.

8.2.7.3 In multi-storage vessel DHWS systems each vessel shall be controlled by a separate temperature control system.

8.2.7.4 Unless otherwise indicated operating elements in hot water storage vessels shall be situated one third up from the bottom of the vessels.

8.2.7.5 Each DHWS calorifier shall be fitted with the limit controls specified in clause 8.2.5.5.

8.2.7.6 Where indicated clock controls shall be provided for the primary heat source.

8.3 CONTROLLERS

8.3.1 Types and Construction

8.3.1.1 Controllers shall be of the following types as indicated:

a) On/off;

b) Proportional;

c) Integral;

d) Proportional plus integral.

8.3.1.2 Controllers shall be contained within a metal case to BS EN 60529 : 1992 IP 54, or as indicated, with a lockable cover suitable for wall, frame or panel mounting as indicated.

8.3.1.3 Basic adjustments (such as slope characteristics, sensitivity, and anti-hunting adjustments) shall be concealed and tamper-proof, the panels being lockable. The remaining control functions shall be accessible and protected by means of lockable and tamper-proof covers.

8.3.2 On/Off Controllers

8.3.2.1 Differentials shall be adjustable over the entire ranges of the controllers.

8.3.2.2 Temperature scales shall be numerical and clearly marked.

8.3.3 Integral Controllers

8.3.3.1 The set points and integral action times shall be adjustable.

8.3.4 Proportional Plus Integral Controllers

8.3.4.1 The set points, proportional bands and integral action times shall be adjustable as appropriate.

8.3.4.2 The controllers shall be able to accept signal inputs from either single or numbers of detectors working together as indicated.

8.4 CONTROL CUBICLES AND PANELS

8.4.1 Construction

8.4.1.1 As far as is practicable all controls, indicator lamps and instruments shall be grouped and mounted together in a cubicle or on a floor or wall-mounted panel. Cubicles and panels shall be constructed to MOD (ex PSA) Standard Specification (M&E) No. 159 and provide the degree of protection to BS EN 60947—1 as indicated. Where busbars, switchgear and fuse-boards are to be included in the control cubicle or panel the assembly shall comply with BS 5486 and BS EN 60439.

8.4.1.2 Cubicles over 1500mm high shall have hinged and lockable access doors with means for internal release. Other panels shall be provided with hinged and lockable access doors or covers at the front of the panel and/or back of the panel as required to facilitate maintenance. Access doors or covers shall incorporate sealing gaskets. Two keys shall be provided which shall be common to all locks on all panels.

8.4.1.3 Access doors or covers shall be so arranged that access to panels cannot be made until an isolating device, interlocked with each door or cover, is opened and all equipment accessible through that door or cover isolated. A purpose-made device shall be provided to enable a competent examiner to override the interlock when the door or cover has been opened.

8.4.1.4 Cubicles or panels shall be installed on builders work bases or secured direct to the floor. Assemblies secured directly to the floor shall incorporate metal plinths. In all cases fixing holes and detachable lifting eyes shall be provided.

8.4.1.5 Cubicles shall be supplied painted internally with a matt white finish, and cubicles and panels shall also be finished externally with a semi-gloss stoved or cellulose enamel finish of BS 4800 colour OOA05, or as approved by the PM. Surfaces shall be properly prepared before final finishing and the external appearance shall be of a high standard.

8.4.1.6 Indicating lamps, instruments and controls shall be, as far as is practicable, from the same manufacturer and of the same style to provide uniformity of appearance and to facilitate maintenance. Externally visible equipment shall be

flush mounted, with minimum projection, and fixed securely to the front panels or other members. Internal equipment shall be secured to purpose-made rails or mounting bars. Fixings shall incorporate shake-proof washers or other vibration resistant fastenings.

8.4.1.7 Approximate positions of the control cubicles are indicated on the Contract drawings. The precise location of control cubicles and panels shall be agreed with the PM on site.

8.4.1.8 Items on the outside faces of cubicles and panels shall be clearly identified by white/black/white laminated engraving plastic labels.

8.4.1.9 Control cubicles and panels shall, as far as is practicable, be manufactured, equipped, wired and tested before delivery to site.

8.4.2 Indicator Lamps

8.4.2.1 Tungsten filament indicator lamp lens colours and colour significance shall comply with BS EN 60073 : 1993 and lenses shall be not less than 25mm in diameter. Indicator lamp transformers shall be of the double wound type and comply with the relevant requirements of BS 3535. Indicator lamps shall be of the following types as indicated:

a) Red neon glow lamps with a rating of 0-5mA.

b) Tungsten filament extra low voltage lamps with a voltage rating 10% higher than their normal supply voltage.

c) Tungsten double filament low voltage lamps of the special service switchboard type with 200/260V nominal voltage and a rating of 12W.

d) Light emitting diodes.

8.4.2.2 Where indicator lamps are not immediately adjacent to their corresponding controller, their function shall be clearly labelled.

8.4.3 Wiring

8.4.3.1 Internal wiring shall be colour coded to BS 6346 and in general shall be bunched and run on trays or in purpose-made slotted plastic cable trunking. Positive fixing of cable ends shall be ensured by purpose-made clamps, pinch-type terminals, crimped cable tags or other approved termination devices. Cable ends shall be permanently identified.

8.4.3.2 Grouped terminal blocks of adequate capacity with permanent labels shall be provided for all wires leading to equipment outside the cubicles or panels. Removable covers or other facilities shall be provided for the entry of incoming cables, conduits, trunking, etc. with means for effective earthing to the cubicles or panel chassis. Non-ferrous earth terminal studs of diameter not less than M6 shall be provided on each panel and cubicle.

8.4.3.3 Where mains power termination occurs at or within control cubicles or panels and the current ratings exceed 100 amperes, soldered socket, crimped or bolted terminals of adequate size shall be provided.

8.4.3.4 The control circuitry within cubicles and panels shall be arranged such that each control system is separately protected. For the purposes of this clause *a* control system shall be defined as that necessary to sustain an item of plant and/or control of a zone. Standby plant shall have separately fused supplies. Fuses, terminal blocks and all items of equipment shall be readily identified by means of clearly visible labels secured to them by screws or other methods approved by the PM.

Section Nine—Miscellaneous Equipment

9.1 THERMOMETERS

9.1.1 General

9.1.1.1 Dial type thermometers shall be of the vapour pressure type. Liquid in glass thermometers shall comply with the requirements of BS 1704 or BS 1041, as appropriate. Where requested by the PM, the Contractor shall demonstrate the accuracy of the thermometers to the requirements of these British Standards.

9.1.1.2 A thermometer shall be fitted on each heating return at its point of connection to the main return header or pipe. Where returns are brought back separately to the boiler a thermometer shall be fitted on each return connection.

9.1.1.3 Thermometers shall be positioned so that the tails are truly subject to the temperature of the water to be measured.

9.1.1.4 Direct (local) mounting thermometers shall have rigid stems either vertical, right angle, or horizontal pattern.

9.1.1.5 Right-angle or horizontal thermometers shall be provided for fitting to vertical pipes or vertical faces of cylinders, etc.

9.1.1.6 Thermometers fitted more than 2m above the floor shall be of the dial type.

9.1.1.7 Thermometer pockets shall comply generally with the requirements of BS 2765 and be inserted, and so positioned in the waterways, that they offer minimum resistance to water flow. Pockets shall be of steel except for copper installations where they shall be of brass. Pockets shall be filled with an approved heat-conducting medium.

9.1.2 LTHW Heating and DHWS Systems

9.1.2.1 Liquid in glass thermometers shall be of the wide-bore lens-magnifying type, enclosed in robust cases. Scales shall be boldly marked and graduated to cover the range 0°C to 120°C.

9.1.2.2 Dial type thermometers shall be as specified in Clauses 9.1.3 but with scales graduated to cover the range 0°C to 120°C.

9.1.3 MTHW and HTHW Heating Systems

9.1.3.1 Dial type thermometers shall be used. They shall be approved metal or moulded plastics cased instruments. They shall be complete with mild steel or stainless steel pressure proof, screwed, separable pockets. Metal cases shall be finished in enamel, with chromium plated bezels.

9.1.3.2 Dials shall be white, not less than 100mm diameter, with black figured scales graduated to cover the range 0°C to 150°C for MTHW systems and to cover the range 0°C to 200°C for HTHW systems.

9.1.3.3 Dial thermometers for remote reading shall be provided with the necessary length of capillary tube encased in a non-corrodible sheath giving protection from mechanical damage. Connecting tubes shall be neatly clipped to walls, etc, with purpose-made clips spaced at not more than 300mm intervals. Thermometers that are to be wall-mounted shall be screwed to the wall.

9.2 PRESSURE GAUGES

9.2.1 Pressure gauges shall comply with BS 1780 with Class I industrial scales. Where requested by the PM, the Contractor shall demonstrate the accuracy of the gauges to the requirements of the BS.

9.2.2 Pressure gauges fitted to plant or pipework associated with steam, LTHW, MTHW and HTHW systems shall have dials calibrated in bar from zero to not less than 1.3 times and not more than twice the operating pressure. Where fitted on pressure vessels and boilers, the gauges shall be as required by BS 759: Part 1 with dials not less than 150mm diameter and with cases of enamelled steel. Where fitted elsewhere, the dials of gauges shall be not less than 100mm diameter and the cases shall be of enamelled

steel or moulded plastics. Pressure gauges shall be fitted with lever handle cocks and, where appropriate, syphon pipes. Pressure gauges shall be of matching finish to dial type thermometers.

9.2.3 Pressure gauges used solely to indicate the altitude or head and pressure of water shall have dials calibrated in bar and metres head. Other gauges shall be calibrated in bar and/or kPa to suit the application. In addition to the indicating black pointer, gauges shall be provided with an adjustable tamper-proof red pointer set to indicate the normal working pressure or head of the system.

9.3 STEAM TRAPS

9.3.1 Steam traps shall be approved and of the following types as indicated:

a) Float with thermostatic air vent,

b) Inverted bucket,

c) Thermostatic balanced pressure,

d) Bimetallic thermostatic,

e) Thermodynamic.

9.3.2 Thermostatic balanced pressure, and bimetallic thermostatic traps shall be preceded by an unlagged cooling leg of length sufficient to prevent waterlogging.

9.3.3 Traps shall be capable of shutting against maximum steam pressure.

9.3.4 Except where integral units are provided a strainer shall be fitted on the inlet side of each trap. Where the condensate is raised to a higher level, a check valve shall be fitted on the outlet side of each trap, except on inverted bucket traps where the check valve shall be fitted on the inlet side. An isolating valve shall be fitted before each strainer and also in the condensate pipework on the outlet from each trap. Unions shall be installed on each side of the complete trap assembly for ease of removal. Mechanical traps shall have renewable valves and seats and shall be provided with automatic air venting valves.

9.3.5 Facilities for detecting steam leakage through traps shall be provided by one of the following methods as indicated:

a) Sensor chambers fitted immediately upstream of traps to be used in conjunction with battery powered indicators.

b) As a) but with remote indicator board.

9.4 STRAINERS FOR HOT WATER HEATING SYSTEMS

9.4.1 Strainers shall be provided to protect meters, control valves and other sensitive fittings or circuits as indicated.

9.4.2 Strainer bodies for line sizes up to DN50 shall be of bronze to BS 1400, PB1, and otherwise of cast-iron to BS 1452, Class 180. Strainer pressure ratings shall be at least 150% of maximum service pressure in the application.

9.4.3 Strainer screens shall be of a suitable stainless steel with perforation free-area at least 250% of line cross-sectional area. The diameter of the perforations shall be in the ranges 0.7-0.9mm and 1.5-1.8mm, for sizes up to DN50 and larger sizes respectively.

9.4.4 Strainers shall be installed in parallel to enable on-line maintenance at the locations as indicated.

9.5 HOT AND COLD WATER MIXING VALVES AND FITTINGS

9.5.1 Thermostatically operated mixing valves shall be of gunmetal or brass construction with chromium-plated finish. Each mixing valve shall be equipped with a backplate for wall fixing. Alternative bodies in thermoplastic material will be considered. Each mixing valve shall have a control thermostat capable of providing a constant mixed water temperature under the available hot and cold water pressures and of closing down the hot water inlet within 5 seconds in the event of the cold water failing. The capacity of each individual shower mixing valve shall be a minimum of 4.5 litre/min. Each mixing valve shall be provided with a temperature regulating handle or knob permitting regulation of the mixed water temperature up to a maximum of 45°C.

Means shall be provided for varying the maximum settings and these shall be tamperproof. The valves shall also have provision for controlling the maximum rate of outlet flow.

9.5.2 Thermostatically operated mixing valves serving groups of showers shall be capable of providing a minimum of 4.5 litre/min simultaneously to each shower and be provided with means of locking the regulating handle to prevent unauthorised interference. The water inlets shall be provided with chromium-plated non-return valves. The construction, finish and thermostatic control regulation of the mixing valve shall be as specified in Clause 9.5.1.

9.5.3 An isolating valve and strainer shall be provided on the hot and on the cold supply to each mixing valve.

9.5.4 Each shower shall be provided with an isolating valve on the riser pipe of type as indicated.

9.5.5 Manually operated mixing valves where indicated shall incorporate anti-scald devices and be suitable for the working conditions.

9.5.6 Unless otherwise indicated showers shall be stainless, robust and vandal resistant installations with fixed spray nozzle terminals.

9.6 GAS METERS

9.6.1 Unless otherwise indicated primary meters will be supplied and fixed under separate arrangements. The Contractor shall connect to the outlet sides of these meters.

9.6.2 Secondary meters, where indicated, shall be supplied and fixed in the positions shown and shall be capable of the duties indicated.

9.6.3 Pressure testing nipples shall be fitted at the outlets of gas meters. A strainer, complying with the meter manufacturer's recommendations, shall be installed on the inlet side of each secondary meter.

9.7 PLATFORMS, GALLERIES, STAIRWAYS AND LADDERS

9.7.1 General

9.7.1.1 Platforms, gantries, galleries, stairways, accessways and ladders shall be provided as indicated to BS 5395 Part 3 and be guarded on all sides with hand-rail systems in accordance with Regulations.

9.7.1.2 Structures shall be fabricated of steel and protectively painted as indicated.

9.7.1.3 Ladders shall comply with BS 4211.

9.7.2 Flooring, Landings and Stair-Treads

9.7.2.1 Flooring and stair-treads shall comply with BS 4592 and the following requirements.

9.7.2.2 Unless otherwise indicated the design loads shall be as stated in BS 4592.

9.7.2.3 The minimum depth of load bearing bars shall be 30mm.

9.7.2.4 Fixing clips shall be provided.

9.7.2.5 Toe plates shall extend at least 100mm above floor level and be fixed down only around cut-outs.

9.7.2.6 The protective finish shall be galvanised to BS 729, etch primed, and dipped in bituminous paint to BS 3416.

9.7.3 Hand-Rail System

9.7.3.1 Hand-rails shall be made using a proprietary system designed to accommodate loads as indicated with a horizontal deflection at half design load not exceeding 0.8% of the pitch between standards, or 25mm whichever is less.

9.7.3.2 Top hand-rails shall be 1100mm above floor level when horizontal and 900mm above stair pitch lines. Intermediate rails shall be provided at mid-height.

9.7.3.3 Rails and ball-standards shall be 32mm nominal bore medium class tube to BS 6323 (Parts 1 to 8).

9.7.3.4 Where rails do not terminate on the structure the finish shall be with return bends. Terminations to the structure shall be made with purpose-made flanges.

9.7.3.5 Ball standards shall be pitched at distances not exceeding 1800mm. Each ball shall have grub-screws for clamping the rails.

9.7.3.6 Toe plates shall be 100mm x 6mm section steel plates spliced together and secured to the ball standards.

9.7.3.7 Ball standards, hand-rails, toe plates, connectors and all fixtures and fittings shall be galvanised after manufacture to BS 729.

9.7.3.8 Joints in hand-rails shall be made using screwed plugs or nipples or internal split dowels. Joints shall be kept clear of standards by at least 20% of the relevant pitch. Joints shall be smooth.

9.7.4 Stairways

9.7.4.1 A common pitch angle not exceeding 42° shall be adopted for the stairways at each location.

9.7.4.2 Flights of stairs shall not exceed 16 risers, and shall not exceed 3.36m or 3.15m in height with pitch angles of 42° and 38° respectively.

9.7.4.3 Where a stairway exceeds 16 risers each flight shall be equal and separated by a landing.

Section Ten—Thermal Insulation

10.1 GENERAL

10.1.1 Thermal insulation and methods of application shall comply with the requirements of BS 5422 and BS 5970. Insulating materials that contain and/or require the use of CFC's in their manufacture, shall not be used.

10.1.2 Thermal insulation materials, adhesives and finishes, shall be suitable in all respects for continuous use without degradation throughout the range of operating temperatures and within the environment indicated. They shall be designed to provide proof against rotting, mould, fungal growth, attack by vermin and birds.

10.1.3 Insulating materials for external application (Clause 10.2.2) shall be approved. The materials shall be such that if subjected to repeated wetting they shall:

a) Retain adequate strength;

b) Not permanently deteriorate in terms of strength and thermal resistance;

c) Continue to be chemically inert to adjacent metalwork.

10.1.4 Unless otherwise indicated as non-combustible, any thermal insulation used in circulation spaces, fire escape routes, ceiling voids or service ducts shall be inherently Class O (ie not achievable by a treatment or covering) as defined by Approved Documents B2/3/4 (1992 Edition) of The Building Regulations 1991 (or the equivalent in Scotland). Insulating materials conforming to Class 1 of BS 476: Part 7 may be used, where indicated, in other areas of buildings.

10.1.5 Any adhesive or surface finish treatment shall not degrade the fire qualities of the insulation material. When requested by the PM, evidence of fire classification obtained from an approved testing laboratory shall be provided by the Contractor.

10.1.6 Where any work is carried out on existing thermal insulation material or finish which contains asbestos in any form, the Contractor's attention is drawn to his responsibilities in accordance with the approved Code of Practice and Guidance Note 'Work with asbestos insulation and asbestos coatings' published by the Health and Safety Executive; 'The Asbestos Regulations' and 'The Environmental Protection Act 1990: Part 1, Special Waste Regulations 1996'.

10.1.7 The minimum thickness of insulation for all hot fluids and cold water distribution services shall be to BS 5422 : 1990, Tables 7 to 15 inclusive, reproduced in this Specification. Where the indicated thickness in these tables is not a commercial size, the nearest larger commercially available thickness of insulation shall be provided. The thickness of insulation in Tables 7 to 15 shall be increased by one standard size, or as indicated, for pipework in external service ducts and pipework external to buildings.

10.1.8 Insulation for protection from condensation shall be provided as indicated.

10.1.9 The thickness of insulation applied to vessels and tanks shall be as indicated in Tables 7 to 15 for flat surfaces.

10.2 TYPES OF INSULANT

10.2.1 Within Buildings

10.2.1.1 Thermal insulation shall be as described below:

a) Boilers, calorifiers, cylinders, boiler feed tanks, steam and condensate receivers (except where insulated jackets are provided) shall be—preformed rigid sections or slabs.

b) All pipework, flanges and valves carrying fluids at temperatures above 50°C and other pipework as indicated shall be pre-formed rigid sections and/or an approved pre-

insulated pipework system as indicated. Valves and flanges shall be insulated in accordance with clause 10.3.4.

c) Flues from oil and solid-fuel fired boilers, gas boilers fired by forced air burners and flues servicing all multi-boiler installations, except diluted flue systems, or where the flue is of pre-insulated or twin wall design shall be preformed rigid sections or slabs, applied direct to the flue and finished with aluminium, or other suitable metallic casing approved by the PM.

d) Heating feed and expansion cisterns and vent pipework shall be insulated as indicated.

e) Unless otherwise indicated, cold water storage tanks, DHWS cold feeds and open vents, incoming mains water services and all CWS distribution pipework shall be insulated. Type of insulation to be as indicated.

10.2.1.2 The operational surface temperature of cladding applied to boilers, other vessels, pipework and flues shall not exceed 55°C in an ambient temperature of 20°C.

10.2.1.3 With the exception of DHWS and CWS incoming main and distribution systems, pipework installed in occupied areas in the following circumstances shall be uninsulated unless otherwise indicated:

a) Pipework whose surface temperature is between 50°C and 95°C and located up to 2m above floor level;

b) Pipework located at less than 2m above floor level which is specifically designated as heating surface and whose surface temperature exceeds 95°C but which is screened against physical contact;

c) Pipework located at more than 2m above floor level which is specifically designated as heating surface.

10.2.2 External to Buildings

10.2.2.1 Preformed insulation shall be applied to:

a) Insulation to steam condensate and hot water distributing mains above ground and in ducts, chases and trenches, including all valve bodies and flanges shall be preformed rigid or flexible sections protected and finished as specified in sub-section 10.4.4.

b) Insulation to cold water pipework run above ground external to buildings and run in ducts, chases, roof spaces shall be preformed rigid or flexible sections.

c) Expansion devices shall be insulated as indicated.

10.3 METHODS OF APPLICATION

10.3.1 The insulation shall fit closely to the pipework and other surfaces without gaps between joints.

10.3.2 Each section of preformed insulation shall be secured to the pipe by one of the following means:

a) Circumferential tie-wires, each formed from one turn of galvanised wire not less than 1.5mm thick, spaced not more than 450mm apart.

b) Circumferential bands, spaced not more than 450mm apart, of galvanised or non-ferrous metal (not less than 20mm wide and 0.5mm thick), plastic fabric (no less than 50mm wide) or adhesive tape.

c) In the case of preformed flexible insulation the manufacturer's recommended method of attachment shall be used.

10.3.3 Rigid insulation applied to boilers, calorifiers, cylinders, hotwells, steam and condensate receivers shall be secured with non-ferrous metal or plastic fixings.

10.3.4 Valve bodies and flanges on insulated pipework in buildings shall be insulated with flexible insulation, encased in aluminium boxes, or other devices approved by the PM. The enclosures shall be arranged for easy removal. The glands on valve spindles shall project beyond the insulation.

10.3.5 Insulation shall be continuous through supports, where the material used shall be capable of supporting the imposed load. Where pipe movement is facilitated by rollers or similar devices, the load bearing insulation shall extend beyond the limits of pipe movement. The Contractor shall ensure that where appropriate the requirements of Clause 10.4.1.1 are satisfied.

10.4 FINISHES

10.4.1 General

10.4.1.1 The preformed insulation outside surfaces shall be smooth, unbroken, uniform and firm. Outer coverings shall be continuous through support joints.

10.4.1.2 Where insulating materials are finished with metallic cladding, the cladding shall be bonded to BS 7671 and BS 7430.

10.4.2 In Boiler Houses and Plant Rooms

10.4.2.1 Insulation on vessels shall be protected and finished by fabricated polished or hammered aluminium or galvanised steel as indicated.

10.4.2.2 Insulation on pipework shall be protected and finished by fabricated polished or hammered aluminium or galvanised steel or rigid plastic as indicated.

10.4.2.3 Fabricated aluminium casings thickness shall be not less than 1mm on vessels and flue piping or ducting, not less than 0.7mm on pipework up to 150mm outside diameter measured over the insulation, not less than 0.9mm on pipework 150mm to 450mm outside diameter measured over the insulation and 1.2mm on pipework over 450mm outside diameter measured over the insulation. Overlap for aluminium and galvanised steel casings at longitudinal and circumferential joints shall be not less than 40mm. Heat bridges between the hot surfaces and the metal casings are not acceptable.

10.4.2.4 Rigid plastic casing shall be made from purpose-designed sheeting not less than 0.35mm thick. Longitudinal and circumferential joints shall be overlapped by 40mm. Longitudinal overlaps shall be neatly secured at 150mm centres with plastic rivets or, with the approval of the PM, with matching self adhesive tape. Circumferential overlap shall allow for expansion and contraction. Bends and tees shall be finished with preformed fittings, unless otherwise indicated.

10.4.3 In Buildings Other Than Boiler Houses And Plant Rooms

10.4.3.1 For concealed pipework the finishes shall be as follows:

a) In roof spaces, foil faced finishing materials, factory applied to preformed sections and secured on site with adhesive, sealing tape and bands where suitable. Alternatively the finish may be site applied to the satisfaction of the PM. The finish shall be left unpainted.

b) Within sealed parts of the building structure, glass cloth facings applied to the insulation and secured on site with adhesive and bands, or finishing material as Clause 10.4.3.1(a), or approved preinsulated and clad as indicated. The finish shall be left unpainted.

c) In all accessible ducts, voids, chases, false ceilings etc, finishing material shall be as Clause 10.4.3.Kb), with fabricated aluminium or galvanised steel or plastic casings applied to the insulation at access points which could be subjected to mechanical damage, or approved preinsulated and clad pipework systems as indicated.

10.4.3.2 For visible pipework the finishes shall be in accordance with the following as indicated:

a) Cotton canvas not less than 100g/m^2 to BS 3958: Part 4, Table 2, factory applied to preformed sections, lapped and sealed on site with adhesive, and additionally secured with bands and painted;

b) Rigid plastics sheet applied in the factory, or on site as Clause 10.4.2.4;

c) White lacquered aluminium foil/kraft paper laminate, factory applied to preformed pipe insulation, overlaps to be sealed with adhesive and circumferential joints to be sealed with 100mm wide matching tape.

10.4.4 External to Buildings In Open Air Or In Ducts

10.4.4.1 The outer covering to the insulation shall be a weatherproof finish which passes continuously without being punctured through pipework supports and over flanges, expansion joints and anchor points.

10.4.4.2 The weatherproof finish to the insulation of pipework carrying fluids at temperatures above ambient shall be one of the following as indicated:

a) Waterproof vapour permeable plastic coating systems, brush or spray applied and reinforced with canvas or glass fibre cloth;

b) Roofing felt, sealed with adhesive with overlaps of at least 50mm, wrapped with 25mm mesh by 1mm thick galvanised wire netting, laced with 1mm thick galvanised wire and painted two coats of bituminous paint to BS 3416 Type 1 Class A;

c) Bitumen impregnated fabric systems sealed by the application of heat or by cold welding;

d) Other proprietary weatherproof finishes of the type as indicated;

e) Preinsulated pipework systems, of the type indicated;

f) Polyisobutylene sheets not less than 0.8mm thickness and of tensile strength 3.4 MPa, lapped and sealed by solvent or cold welding.

The finishes specified in Clause 10.4.4.2(b) and (c) shall be perforated on the under side of all horizontal runs with 6mm diameter holes at approximately 150mm centres. The horizontally lapped joints shall lie to one side of the bottom centre line exposed edge downwards, so that the perforations are made in one thickness of the material, with the underlying preformed insulation open to atmosphere at these points.

10.4.4.3 The weatherproof finish to the insulation of cold water pipework shall be as Clause 10.4.4.2(b), (c), (d), (e) or (f).

10.4.5 PAINTING

10.4.5.1 Insulation shall be painted two coats good quality heat-resistant paint of approved colour as indicated, except where concealed, protected by metal or plastics casings, or has weatherproof or special decorative/protective finishes. Absorbent surfaces shall have a first coat of primer paint.

10.4.5.2 The paint system shall not adversely affect the required fire resisting properties to BS 476: Part 7—Class 1.

10.4.6 Colour Code

10.4.6.1 Pipework whether insulated, insulated and cased or uninsulated shall be identified with purpose-made self-adhesive colour banding with colours to BS 1710. Direction of flow shall also be indicated. The locations of identifying bands shall be as indicated.

TABLES OF THERMAL INSULATION THICKNESS

(Based on BS 5422 : 1990—Method of specifying Thermal insulating materials on pipes, ductwork and equipment (in the temperature range —40°C to +700°C).

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TABLE 10A MINIMUM THICKNESS OF INSULATION FOR COLD WATER SUPPLIES TO PREVENT CONDENSATION ON A HIGH EMISSIVITY OUTER SURFACE (0.9) WITH AN AMBIENT TEMPERATURE OF +25°C AND A RELATIVE HUMIDITY OF 80%.

Outside diameter of steel pipe on which insulation thickness has been based (in mm)	Temperature of contents (in °C)			
	+10			
	Thermal conductivity at mean temperature (in W/(m·K))			
	0.02	0.03	0.04	0.05
	Thickness of insulation (in mm)			
21.3	6	8	9	11
33.7	6	8	11	13
60.0	6	9	12	14
114.3	6	9	12	14
168.3	6	9	12	15
273.0	6	9	13	16
508.0	7	10	13	16
Flat surfaces	7	10	14	17

TABLE 10B MINIMUM THICKNESS OF INSULATION FOR COLD WATER SUPPLIES TO PREVENT CONDENSATION ON A LOW EMISSIVITY OUTER SURFACE (0.2) WITH AN AMBIENT TEMPERATURE OF +25°C AND A RELATIVE HUMIDITY OF 80%.

Outside diameter of steel pipe on which insulation thickness has been based (in mm)	Temperature of contents (in °C)			
	+10			
	Thermal conductivity at mean temperature (in W/(m·K))			
	0.02	0.03	0.04	0.05
	Thickness of insulation (in mm)			
21.3	10	14	17	20
33.7	11	16	20	24
60.0	13	18	23	28
114.3	14	20	27	33
168.3	15	23	31	39
273.0	17	26	34	42
508.0	19	28	36	44
Flat surfaces	21	31	41	52

TABLE 10C CALCULATED MINIMUM THICKNESS OF INSULATION REQUIRED TO GIVE PROTECTION AGAINST FREEZING UNDER INDUSTRIAL CONDITIONS

Water temperature		+5°C				+5°C			
Ambient temperature		-10°C				-10°C			
Evaluation period		12 h				12 h			
Permitted ice formation		Nil				10%			
Outside diameter	Inside diameter (bore)	Thermal conductivity (in W/(m·K))							
		0.02	0.03	0.04	0.05	0.02	0.03	0.04	0.05
mm	mm	Thickness of insulation (in mm)							
Steel pipes[1)]									
21.3	16.0	—	—	—	—	1034	—	—	—
26.9	21.6	5028	—	—	—	179	715	2740	—
33.7	27.2	716	4812	—	—	74	195	473	1121
42.4	35.9	203	708	2349	—	37	75	137	240
48.3	41.8	124	340	875	2195	28	51	85	135
60.3	53.0	66	141	275	513	19	32	48	69
76.1	68.8	41	75	123	193	13	21	30	40
88.9	80.8	31	54	84	122	11	17	24	31
114.3	105.3	22	35	51	70	8	12	17	21
168.3	158.6	14	21	29	37	5	8	10	13
219.1	207.9	10	16	21	27	4	6	8	10

NOTES. For commercial and institutional applications see Table 10D. Obviously some of the theoretical thicknesses in this table are uneconomic or impracticable and should not be installed. In such cases, other means of protection, e.g. trace-heating or water flow, should be used to supplement the protection that is afforded by the actual thickness of insulation adopted.

1) Outside diameters shown are as given in table 2 of BS 1387 : 1985. Thickness of insulation for other pipe outside diameters can be obtained by interpolation or extrapolation.

TABLE 10D CALCULATED MINIMUM THICKNESS OF INSULATION TO PROTECT AGAINST FREEZING FOR COMMERCIAL AND INSTITUTIONAL APPLICATIONS

Water temperature		+5°C				+5°C			
Ambient temperature		−3°C				-5°C			
Evaluation period		24 h				24 h			
Permitted ice formation		50%				50%			
Outside diameter	Inside diameter (bore)	Indoors				Outdoors			
		Thermal conductivity (in W/(m·K))							
		0.025	0.035	0.045	0.055	0.025	0.035	0.045	0.055
mm	mm	Thickness of insulation (in mm)							
Copper pipes[1]									
15.0	13.6	31	56	83	109	109	340	1032	3101
22.0	20.2	13	21	31	45	28	52	93	159
28.0	26.2	8	13	18	24	16	26	40	58
35.0	32.6	7	9	13	16	11	17	24	33
42.0	39.6	5	7	9	12	9	13	17	22
54.0	51.6	4	5	7	8	6	9	12	15
76.1	73.1	3	4	5	6	4	6	8	9
108.0	105.0	2	3	3	4	3	4	5	6
Above 108.0mm outside diameter and flat surfaces		2	3	3	4	3	4	5	6
Steel pipes [2)]									
21.3	16.1	23	40	62	85	59	137	303	659
26.9	21.7	13	20	29	43	26	46	77	124
33.7	27.3	9	13	19	25	16	27	40	57
42.4	36.0	6	9	12	15	11	16	22	29
48.3	41.9	5	7	9	12	9	12	17	22
60.3	53.1	4	5	7	9	6	9	12	15
76.1	68.9	3	4	5	6	5	7	9	11
88.9	80.9	3	4	4	5	4	6	7	9
Above 88.9mm outside diameter and flat surfaces		3	4	4	5	4	6	7	9

NOTES. Obviously some of the theoretical thicknesses in this table are uneconomic or impracticable and should not be installed. In such cases, other means of protection, e.g. trace-heating or water flow, should be used to supplement the protection that is afforded by the actual thickness of insulation adopted.

1) To table X of BS EN 1057
2) To table 4 of BS 1387

TABLE 10E ECONOMIC THICKNESS OF INSULATION FOR NON-DOMESTIC HEATING INSTALLATIONS SERVED BY SOLID FUEL-FIRED BOILER PLANT

Outside diameter of steel pipe on which insulation thickness has been based (in mm)[1)]	Hot face temperature (in °C) (with ambient still air at +20°C)											
	+75				+100				+150			
	Thermal conductivity at mean temperature (in W/(m·K))											
	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07
	Thickness of insulation (in mm)											
17.2	14	17	20	23	17	21	24	26	22	25	28	32
21.3	15	18	22	24	17	22	25	27	23	26	30	34
26.9	17	20	23	25	20	24	26	28	24	28	32	35
33.7	17	21	24	26	20	25	27	31	25	29	34	37
42.4	18	22	25	27	21	25	28	32	25	31	35	39
48.3	18	23	25	28	22	26	29	33	26	32	36	41
60.3	19	24	26	29	23	27	31	35	27	33	38	43
76.1	20	24	27	31	23	28	33	36	28	35	40	45
88.9	20	24	28	32	24	28	33	37	29	36	42	46
114.3	21	25	29	33	25	30	35	39	31	37	44	48
139.7	22	26	30	34	25	31	36	41	31	38	45	50
168.3	22	26	31	35	25	32	37	42	32	40	46	52
219.1	22	27	32	36	26	33	38	43	33	42	48	54
273.0	23	27	33	36	26	34	39	44	34	43	49	55
Above 323.9 and including flat surfaces	23	28	34	38	27	35	42	47	35	45	53	60

1) Outside diameters are as in BS 3600. The same thickness of insulation would be used for copper pipework of approximately similar outside diameters.

TABLE 10F ECONOMIC THICKNESS OF INSULATION FOR NON-DOMESTIC HEATING INSTALLATIONS SERVED BY GAS BOILER PLANT

Outside diameter of steel pipe on which insulation thickness has been based (in mm)[1)]	Hot face temperature (in °C) (with ambient still air at +20°C)											
	+75				+100				+150			
	Thermal conductivity at mean temperature (in W/(m·K))											
	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07
	Thickness of insulation (in mm)											
17.2	17	22	24	26	20	24	27	31	24	29	34	37
21.3	18	23	25	27	22	25	29	33	26	32	36	39
26.9	20	24	26	29	23	27	31	34	27	33	38	42
33.7	21	25	27	31	24	28	33	36	28	35	40	44
42.4	22	25	29	32	25	30	34	38	30	37	42	47
48.3	22	26	30	33	25	31	35	39	31	38	44	48
60.3	23	27	32	35	26	32	37	41	33	39	46	50
76.1	24	28	33	36	27	34	39	43	34	42	48	52
88.9	24	29	34	37	28	35	40	45	35	43	49	53
114.3	25	31	35	39	29	36	42	47	36	45	51	56
139.7	25	32	36	41	30	37	43	48	37	47	53	59
168.3	25	32	37	42	31	38	45	50	38	48	56	61
219.1	26	33	38	44	32	40	46	52	40	51	58	65
273.0	27	34	40	45	33	41	47	53	41	52	59	68
Above 323.9 and including flat surfaces	27	36	42	47	34	43	51	58	42	54	63	72

1) Outside diameters are as in BS 3600. The same thickness of insulation would be used for copper pipework of approximately similar outside diameters.

TABLE 10G ECONOMIC THICKNESS OF INSULATION FOR NON-DOMESTIC HEATING INSTALLATIONS SERVED BY OIL-FIRED BOILER PLANT

Outside diameter of steel pipe on which insulation thickness has been based (in mm)[1)]	Hot face temperature (in °C) (with ambient still air at +20°C)											
	+75				+100				+150			
	Thermal conductivity at mean temperature (in W/(m.K))											
	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07
	Thickness of insulation (in mm)											
17.2	18	23	25	28	22	26	29	33	26	32	36	40
21.3	19	24	27	29	23	27	32	35	27	34	38	43
26.9	21	25	28	32	24	29	33	36	29	35	41	45
33.7	22	26	29	33	26	31	35	38	31	37	43	47
42.4	23	27	32	35	26	32	37	41	32	39	45	50
48.3	24	28	33	36	27	33	38	42	33	41	46	51
60.3	25	29	34	37	28	35	39	44	35	43	49	52
76.1	25	31	35	39	29	36	42	46	36	45	50	55
88.9	25	32	36	41	30	37	43	48	37	46	51	57
114.3	26	33	38	43	31	38	44	49	39	48	54	60
139.7	27	34	39	44	33	41	47	51	41	50	57	63
168.3	27	35	41	45	33	42	48	54	42	52	59	66
219.1	28	36	42	47	34	43	51	56	43	54	62	69
273.0	29	37	43	48	35	44	52	57	45	55	64	71
Above 323.9 and including flat surfaces	31	38	45	52	37	47	55	62	47	60	69	77

1) Outside diameters are as in BS 3600. The same thickness of insulation would be used for copper pipework of approximately similar outside diameters.

TABLE 10H ECONOMIC THICKNESS OF INSULATION FOR NON-DOMESTIC HOT WATER SERVICES

Outside diameter of steel pipe on which insulation thickness has been based (in mm)[1)]	Water temperature +60°C											
	Solid Fuel				Gas				Oil			
	Thermal conductivity at mean temperature (in W/(m·K))											
	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07	0.025	0.04	0.055	0.07
	Thickness of insulation (in mm)											
17.2	17	21	24	27	20	24	28	32	22	27	31	34
21.3	18	22	25	28	22	26	30	34	23	28	32	36
26.9	20	23	27	29	23	28	32	35	24	29	34	38
33.7	20	24	28	31	24	29	33	37	26	31	36	40
42.4	21	26	30	33	25	31	34	39	28	33	38	42
48.3	22	27	31	34	26	32	36	40	29	34	39	43
60.3	23	28	32	36	27	33	38	42	30	36	41	45
76.1	23	29	34	37	28	35	40	44	31	37	42	47
88.9	24	30	35	38	29	36	41	45	32	38	44	48
114.3	25	31	36	40	30	37	43	47	33	40	46	51
139.7	25	32	37	41	31	38	44	50	34	41	47	54
168.3	26	33	38	42	32	39	45	52	34	42	51	56
219.1	26	34	39	44	33	41	47	55	35	44	53	59
273.0	27	35	40	45	34	42	51	57	36	45	55	61
Above 323.9 and including flat surfaces	29	36	42	50	35	44	54	61	40	51	59	65

[1)] Outside diameters are as in BS 3600. The same thickness of insulation would be used for copper pipework of approximately similar outside diameters.

TABLE 10J ECONOMIC THICKNESS OF INSULATION FOR PROCESS PIPEWORK AND EQUIPMENT

Outside diameter of steel pipe (in mm)	Hot face temperature at mean temperature (in °C)(with ambient still air at +20°C)														
	+100					+200					+300				
	Thermal conductivity at mean temperature (in W/(m-K))														
	0.02	0.03	0.04	0.05	0.06	0.03	0.04	0.05	0.06	0.07	0.03	0.04	0.05	0.06	0.07
	Thickness of insulation (in mm)														
17.2	28	31	35	38	41	45	49	52	56	59	52	57	61	66	70
21.3	29	37	37	40	43	46	50	54	58	62	55	60	65	70	74
26.9	31	35	39	43	46	50	54	59	63	67	59	64	69	74	78
33.7	33	36	40	44	48	52	56	61	65	69	61	66	72	77	82
42.4	36	40	45	49	53	56	61	67	72	77	67	73	79	84	90
48.3	38	42	47	51	55	59	64	70	75	80	70	77	82	88	95
60.3	41	45	50	55	59	63	69	75	81	86	76	82	89	96	102
76.1	42	47	52	57	62	67	73	79	85	90	78	86	94	101	107
88.9	44	49	54	59	64	70	76	82	89	94	83	90	98	105	112
101.6	45	50	56	62	66	73	79	85	91	97	85	93	101	109	116
114.3	46	52	57	63	68	76	80	87	93	99	87	95	103	111	118
139.7	49	54	60	66	71	78	84	92	99	105	94	102	110	118	125
168.3	52	58	64	70	76	83	90	98	105	111	101	107	117	126	134
219.1	54	60	67	74	80	87	95	104	112	119	105	114	124	133	142
244.5	55	62	69	76	82	89	98	106	115	122	108	117	127	137	146
273.0	56	64	71	78	84	94	100	110	118	126	113	120	132	142	151
323.9	58	66	73	80	86	94	104	114	123	132	115	123	135	145	154
355.9	59	67	74	81	88	97	107	116	125	134	116	125	137	147	156
406.4	62	69	76	83	90	100	109	118	127	136	118	128	140	150	159
457.0	63	70	77	84	91	102	111	120	129	138	121	132	144	154	163
508.0	65	72	79	86	93	105	114	123	132	141	124	134	146	156	165
Over 508 and including flat surfaces	72	78	87	98	105	113	124	133	142	151	127	137	151	161	170

Section Eleven—Electrical Equipment and Wiring

11.1 GENERAL

11.1.1 Unless otherwise indicated the Contractor shall provide and install all electrical equipment necessary for the complete installation and carry out all wiring from point(s) of supply indicated on the drawing(s).

11.1.2 The Contractor shall be responsible for the accuracy of all wiring diagrams provided by him and for the correct internal wiring of all pre-wired equipment supplied for the contract.

11.1.3 Unless otherwise indicated all electrical equipment shall be suitable for use in ambient temperatures up to 40°C and relative humidities up to 90%. Equipment shall be proof against atmospheric corrosion, including saline air where indicated, and material shall not be susceptible to mould growth or attack by vermin.

11.1.4 The electrical installation shall comply with MOD Functional Standard Specification 034 and the following requirements. Any discrepancies shall be referred to the PM who will decide on precedence.

11.2 ELECTRIC MOTORS

11.2.1 Motors shall comply with BS 2048, BS 4999 and BS 5000 as appropriate and shall be of sizes and types to drive the equipment under normal conditions of service without overloading. Motors greater than 0.75 kW output shall be suitable for operation from a three-phase supply unless otherwise indicated or agreed with the PM.

11.2.2 Fan, pump, stoker and burner motors shall be continuously rated. The insulation shall comply with BS 2757. Classes Y and A shall not be used.

11.2.3 Motor enclosures shall comply with BS 4999: Part 105. The degree of protection shall be IP 44, or as indicated, with the exception of the following:

a) Solid fuel boiler houses—IP54 or as indicated.

b) Condensate pumps—IP55 or as indicated.

11.2.4 Each motor circuit shall be provided with an isolator, switch or circuit breaker in the motor starter, operable under load.

11.2.5 Where a motor is not visible from the motor starter position, or where the PM decides necessary, an isolator, switch or push-button shall be provided adjacent to or mounted on the motor. See Clauses 11.3.4 and 11.3.5.

11.2.6 Motors arranged for automatic starting shall have a label of durable material permanently affixed in a prominent position and having, in clearly inscribed characters, the legend:

> DANGER. THIS MOTOR IS AUTOMATICALLY CONTROLLED AND MAY START WITHOUT WARNING. ISOLATE BEFORE INSPECTION.

11.3 CONTROL GEAR

11.3.1 Starters shall comply with BS EN 60947—1: 1992 and be rated for utilisation category AC3 and intermittent duty, class as indicated. Unless otherwise indicated, starters for motors up to 5kW shall be direct-on-line, and above 5kW they shall be star-delta or other assisted start.

11.3.2 Contactor operating coils shall be supplied at no more than 240 volts. Where operation is remotely controlled a protective fuse shall be provided. All starters shall be provided with load-breaking isolating switches which shall be lockable.

11.3.3 The control gear for each motor of more than 0.5kW rating shall include:

a) Under-voltage protection (but see Clause 11.3.4).

b) Emergency stop push-button as indicated.

c) In each phase of a three-phase motor, a hand reset combined thermal overload and single-phasing protection device.

11.3.4 Isolators and switches shall be capable of interrupting full load current, including stalled motor current, and shall be lockable.

11.3.5 Push-buttons shall be of the mushroom-headed, twist-to-reset, type arranged to directly control the motor starter.

11.3.6 Motors for circulators and all other motors under automatic control, other than those associated with the firing equipment of steam boilers, shall have starters arranged for automatic restart after power failure when mains voltage is restored.

11.3.7 Facilities shall be provided for alternative hand operation of automatically controlled starters and contactors.

11.3.8 Protective fuses shall be to BS 88.

11.4 ENCLOSURES

11.4.1 Control gear may be mounted within a cubicle or panel as described in Section 8.4.

11.4.2 Electrical equipment shall be provided with entries for screwed conduit or for mineral insulated cable as indicated. Large items of equipment shall have removable gland plates to facilitate the flanging of trunking.

11.5 IMMERSION HEATERS FOR HOT WATER

11.5.1 These shall be supplied by the Contractor or issued to him as indicated and shall be of the ratings indicated.

11.5.2 Elements shall be of the metal sheathed rod type with the resistor embedded in refractory material. Manufacture shall be from materials recommended by the local electricity company for the water supply of the particular area.

11.5.3 Elements shall be firmly brazed to brass or gunmetal heads. Soft soldering will not be accepted. Heads shall be octagonal and screwed 2/4 BSP medium fit, and provided with a jointing washer and sweating flange.

11.5.4 Heads shall be complete with connection chambers with removable covers, having line, neutral and earth terminals and bushed cable entries or screwed entries for conduit, as required.

11.5.5 Heaters rated up to 3kW shall comply with BS 3456: Part 1 and BS 3456 Section 2.21, except as modified by this Specification. Other heaters shall comply with BS 3456: Part 1 and BS 3456 Section 2.21, as far as is practicable.

11.5.6 Each single-phase heater shall incorporate an adjustable thermostat having a range of adjustment between 50°C and 80°C.

11.5.7 Each poly-phase immersion heater shall be controlled by an adjustable thermostat having a range of adjustment between 50°C and 80°C installed in an immersed pocket and operating through an electrical contactor.

11.6 FAN CONVECTORS

11.6.1 Unless otherwise indicated an adjacent 230 volts 13 ampere socket or a fused-spur outlet will be provided under separate contract to supply each fan convector.

11.7 BONDING

11.7.1 The Contractor shall ensure that all the metallic installations which constitute 'Extraneous conductive parts' shall be electrically bonded in accordance with BS 7671.

11.7.2 Metallic gas pipework shall be electrically continuous. Flanged, grooved or compression type fittings in gas pipes shall be electrically bonded. Gas pipework shall be electrically bonded to electrical earth terminals to BS 7671 and BS 7430.

11.8 TESTING

11.8.1 The Contractor shall supply a Test Certificate for each electrical installation and appropriate items of electrical equipment which are normally subject to tests. Unless otherwise indicated the Certificates shall be made up using MOD forms supplied by the PM. The Certificates shall guarantee that the electrical installation or electrical equipment has been fabricated, inspected and satisfactorily tested in accordance with BS 7671 and any other relevant Regulation.

Section Twelve—Inspection, Tests and Commissioning

12.1 INSPECTIONS BY COMPETENT PERSON

12.1.1 Certain equipments and installations shall be made available during design, fabrication, construction, installation and commissioning for inspections by a Competent Person (CP) who is as indicated. The CP will be acting as the PM's representative and the Contractor shall provide information and access as necessary to satisfy the CP that the particular technical and legal requirements of the Contract have been met. Equipment and installations indicated as requiring inspection(s) will not be accepted until the CP has certified the designs, fabrication, construction, installation and performances as relevant. The inspection and testing activities shall be taken into account when programming the Works.

12.1.2 The Contractor shall notify the PM in writing as soon as possible after the Contract has been awarded of the particular equipment and installations which require the CP's attendance. The PM will place Order(s) with the CP upon receipt of such notification, and the CP will make direct contact with the Contractor to agree technical details and the programme of attendances on the Site or elsewhere as relevant.

12.1.3 In mutual agreement with the CP the Contractor shall provide detailed drawings of the equipment and installations prior to fabrication and/or construction and/or installation, and shall arrange for Works and/or site visits for inspections and/or Statutory Examinations as relevant.

12.1.4 The following list of equipment and installations, together with their mountings and accessories, shall be subjected to inspections by the CP:

a) Boilers: steam, HTHW, MTHW and LTHW as indicated.

b) Pressure vessels: steam receivers, air receivers, pressurising and expansion vessels incorporated in boiler plant unless otherwise indicated.

c) Calorifiers, heat-exchangers and pressure vessels incorporated in steam, HTHW and MTHW heating and domestic hot water systems.

d) Pressurised system mains and distribution pipework as indicated.

e) Fuel tanks as indicated.

f) Steel chimneys and flues as indicated.

g) Any other pressure system.

h) Other systems and equipment as indicated.

12.2 RESPONSIBILITY FOR REPORTING INFRINGEMENT OF REGULATIONS

12.2.1 Throughout the execution of the Works the Contractor shall be responsible for ensuring compliance with all relevant safety regulations including the regulations listed in Section 1.6 and shall notify the PM of any infringements which directly or indirectly detract from the safe and satisfactory operation of the installation(s), whether or not such infringements relate to the Works or to the associated works of others.

12.3 CLEANLINESS

12.3.1 Things for incorporation in the Works shall be kept in protective storage until needed. Tubes and equipment shall be kept effectively plugged, capped or sealed prior to installation.

12.3.2 Before installations are commissioned and subjected to the inspections and tests required in Section 12.4, they shall be thoroughly cleaned internally and externally.

12.3.3 All items that could be damaged by scavenging or cleaning shall be suitably protected and cleaned by alternative approved methods.

12.3.4 Internal cleaning for gas installations shall include scavenging with steam or compressed air.

12.3.5 Fuel oil installations shall be cleaned by steam purging or flushing with water at velocities not less than 1.5m/s. Water flushing shall include detergent treatment as approved by the PM.

12.3.6 Steam and condensate systems shall be scavenged with steam or compressed air.

12.3.7 Internal cleaning for hot water heating installations shall include flushing, chemical cleaning, passivation and final flushing to a written specification approved prior to starting, or as indicated. Cleaning procedures shall be carried out in compliance with the recommendations contained in CIBSE Code 'W and the Code of Practice for the use of High Pressure Water Jetting Equipment as relevant.

12.3.8 DHWS and CWS installations shall be flushed, cleaned and disinfected to a written specification approved prior to starting, or as indicated. Cleaning for these systems shall be in accordance with the requirements and recommendations contained in BS 6700.

12.3.9 Effluent from cleaning processes shall be discharged into the foul-drainage system in compliance with the requirements of the local Water Company.

12.4 INSPECTION AND TESTS ON COMPLETION

12.4.1 Boiler plant, tanks, cylinders, pumps, etc, specified to comply with British Standards shall be subject to tests at works in accordance with the relevant BS. Materials or plant not covered by a BS, shall be subjected to a hydraulic test at works of 1.5 times the maximum working pressure, or of 1.5 bar, whichever is the greater, for a period of 30 minutes.

12.4.2 Test certificates for works tests required by British Standards shall be submitted in duplicate to the PM.

12.4.3 Completed hot water heating, DHWS, steam, and condensate systems shall be subjected to hydraulic pressure tests after cleaning. The systems shall be tested to 1.5 times working pressure for not less than 30 minutes. Steam blowdown systems shall be designed, tested and operated in accordance with Health and Safety Executive Guidance Note PM60. Items of equipment such as safety valves and bursting discs set to operate below test pressure shall be isolated during testing. After satisfactory tests, systems shall be drained, dried, filled with preserving solution or filled with treated water as indicated.

12.4.4 After being cleaned cold water systems shall be recharged with clean water and tested as follows. Storage cisterns and distributing pipe-work shall be watertight under working conditions of pressure with all draw-off taps closed. Water mains and service pipework shall be subjected to a hydraulic test pressure of 9 bar or 1.5 times the maximum working pressure, whichever is the greater. This pressure shall be maintained without measurable loss for at least 30 minutes.

12.4.5 After being cleaned fuel oil systems shall be hydraulically tested for 30 minutes to 1.5 times the working pressure or 7 bar, as indicated, without leakage. Suction lines that may be subjected to sub-atmospheric pressure, shall be tested to a negative pressure of 0.3 bar for 30 minutes with a maximum loss of 0.03 bar, as detailed in BS 5410: Part 2.

12.4.6 After being cleaned gas installations shall be tested for soundness and purged in accordance with IGE/UP/1 or BS 5482: Part 1 as relevant.

12.4.7 Installations, or sections thereof, which will be embedded in the structure or concealed (in accordance with Clause 4.1.4) shall, in addition to the above specified tests, be individually tested as they are laid and prior to being embedded or concealed.

12.4.8 Unless otherwise indicated, pressure tests shall be carried out on completed systems prior to the application of thermal insulation. Subject to agreement with the PM, sub-sections or sub-systems may be tested before system completion to facilitate the insulation work. These advanced tests shall be witnessed and certified by the PM's representative. This shall not relieve the Contractor of the responsibility to pressure test the completed system and show satisfactory results.

12.5 TESTS GENERALLY

12.5.1 The PM shall receive 7 calendar days notice of all tests on items for incorporation, system and/or sub-systems on or off the site.

12.5.2 Unless indicated otherwise, fuel, water (other than treated water) and electricity necessary for the operation of the heating and/or hot water service plants, in preliminary runs and for adjustments and tests, will be provided free of cost to the Contractor.

12.5.3 The Contractor shall supply all labour, apparatus and instruments necessary for tests. Where required by the PM, the Contractor shall demonstrate that the accuracy of instruments used either by him, or by an independent specialist employed by him, is within the tolerances permitted by the relevant BS.

12.5.4 Any defects of workmanship, materials, performance, design of equipment, maladjustments or other irregularities shall be rectified by the Contractor and the tests repeated at the Contractor's expense, to the satisfaction of the PM.

12.6 COMMISSIONING

12.6.1 Each installation shall be fully commissioned in accordance with the CIBSE Codes B and W and BSRIA Application Guide AG 2/89.1—The Commissioning of Water Systems in Buildings. Unless otherwise indicated the Contractor shall arrange for the commissioning engineers to survey the installations and submit a commissioning schedule and programme, to the PM for comment, at least 6 weeks before commencement of commissioning.

12.6.2 Commissioning shall be undertaken by the Contractor or by an approved independent commissioning specialist as indicated. The sum allocated for commissioning shall be stated separately in the Summary of Tender.

12.6.3 Before any commissioning is started, the Contractor shall ensure that each installation has been cleaned, inspected and pressure tested and that the requirements of Section 11.8 have been satisfied.

12.6.4 Pipe systems shall be modified in accordance with good pipework practice as necessary prior to regulation so that flow rates with all valves open are within 50% of the design rates. Fluid flow rates shall be adjusted to within 95% and 110% of design unless otherwise agreed by the PM.

12.6.5 Results of commissioning tests shall be recorded by the Contractor on the Commissioning Certificates provided. Unless otherwise indicated each certificate shall be signed by the Contractor and endorsed by the PM or his representative.

12.7 BOILER PERFORMANCE TESTS

12.7.1 The Contractor shall arrange for performance tests to be carried out on each boiler, to establish thermal efficiency at maximum combustion rate, at minimum combustion rate and at about midway between when relevant. These tests shall be witnessed by the PM together with a senior representative from the Contractor.

12.7.2 The Contractor may elect to carry out the tests on LTHW and DHWS boiler plant himself or alternatively appoint an approved independent specialist.

12.7.3 HTHW, MTHW and steam boiler plant shall be tested by a nominated specialist or an approved specialist engaged by the Contractor as indicated. The test shall be witnessed by the CP.

12.7.4 The tests shall demonstrate to the PM that the thermal efficiency of each boiler is not less than that guaranteed by the Contractor in his tender.

12.7.5 The boiler performance tests required by Clause 12.7.1 shall comply with BS 845: Part 1, based on flue gas losses measured at the flue gas exit from each boiler. The results of the tests shall be recorded on a Boiler Test Report, which shall be endorsed by the PM or his representative.

12.7.6 Should completion of the Works and the readiness to conduct proving tests coincide with a period when difficulty may be experienced in securing operating conditions consistent with eventual design performance, the boiler plant will be provisionally accepted subject to tests at a later date. This date shall be agreed between the PM and the Contractor but shall not be later than six months from the date of provisional acceptance. If the tests at this later date confirm the acceptability of the boiler plant, the completion date, for this purpose of determining commencement of the defect liability period, shall be the date of provisional acceptance. If any proving test fails to meet the performance standard specified, the Contractor shall make good the defect at his own cost and the conditions of the contract relating to the defect liability period shall apply to the portions of the Works so made good until the expiration of the appropriate period or the expiration of six months from the date of such making good, whichever is the later.

12.7.7 Boiler efficiencies shall comply with the requirements of the EC Boiler Efficiency Directive.

Schedule No. 1—Particular Application to this Contract

Clause	*Item	*Options/Requirements
1.1.2	Scope of the work	See Particular Specification
1.1.3	Planned maintenance	See Particular Specification
1.2.10	Types of gases	See Particular Specification
1.5.5	Abnormal BS	See Particular Specification
1.7.1.1	Working drawings (see Contract Forms)	See Particular Specification
1.7.3.1	As installed drawings	See Particular Specification
1.7.3.2	As installed drawings-draft	See Particular Specification
1.8.1, 1.8.2	Maintenance and operating documents	See Particular Specification
1.9.1	Abnormal power supply	See Particular Specification
1.11.2	Painting	See Particular Specification
2.1.2	Boilers special requirements	See Particular Specification
2.1.4	Tools	See Particular Specification
2.1.5	Bases	See Particular Specification
2.1.6	Boiler test efficiencies	High ..... % Low ..... % Inter ..... %
2.1.11	Exit temperature	See Particular Specification
2.2.2.1	Shell boilers	BS 855/BS 2790
2.2.3.1	Shell boilers	BS 855/BS 2790
2.2.6.1	Waste heat boilers Dry operating capacity	BS 855/BS 1113/BS 2790 Reqd/Not reqd
2.2.7.1	Electric boilers	BS1894/BS5500
2.3.1.1 b)	Boiler water flow resistances	See Particular Specification
2.3.2.1	Shell boilers	BS 855/BS 2790
2.3.2.1c)	Boiler water flow resistances	See Particular Specification

Clause	*Item	*Options/Requirements
2.3.3.1	Shell boilers	BS 855/BS 2790
2.3.3.1c)	Boiler water flow resistances	See Particular Specification
2.3.4	Additional requirements	See Particular Specification
2.3.4.1 b)	Boiler water flow resistances	See Particular Specification
2.3.5.1c)	Boiler water flow resistances	See Particular Specification
2.3.6.1	Waste heat boilers	BS855/BS1113/BS2790
2.3.6.1c)	Boiler water flow resistances	See Particular Specification
2.3.6.1 d)	Dry operating capability	Reqd/Not reqd
2.3.9.1e)	Options	See Particular Specification
2.5.1	Condensing boiler	See Particular Specification
2.5.2	Material	See Particular Specification
2.6.1.2	Firing methods	a/b/c/d/See Particular Specification
2.6.1.3	Noise levels	NR ...../See Particular Specification
2.7.1.1	Solid fuel installations	See Particular Specification
2.7.2.1	Abnormal oil installations	See Particular Specification
2.7.2.4	Oil tanks: types and sizes	See Particular Specification
2.7.2.6	Oil tanks: surface coating spec. Insulation	See Particular Specification See Particular Specification
2.7.2.8 b)	Oil tanks: contents indicators	Dip-stick/Tape
2.7.2.8 g)	Tank immersion heaters	See Particular Specification
2.7.2.9 d)	Trace heating Temperature	See Particular Specification C
2.7.2.9 e)	Circ. pumps	See Particular Specification
2.7.2.13	Oil heater types	See Particular Specification
2.7.2.22	Foam inlets Other arrangements	See Particular Specification See Particular Specification
2.7.3.1	Gas fired boilers Duties Burner types	 See Particular Specification See Particular Specification
2.7.3.3	Gas boosters	See Particular Specification
2.7.4.2	Proven coal performance	See Particular Specification
2.8.1.1	Controller casing location	See Particular Specification
2.8.1.3	Controller reset	Reqd/Not reqd
2.8.1.5	Abnormal cubicle and panel specs.	See Particular Specification
2.8.2.1	Oil burner control method	a/b/c/See Particular Specification
2.8.2.2	Set-point pressure range	..... to .....(bar)

Clause	*Item	*Options/Requirements
2.8.2.3	Set-point temperature range	..... to .....(°C)
2.8.3.1	Gas burner control	See Particular Specification
2.8.3.3	Gas burner control method	a/b/c/See Particular Specification
2.8.4.2	Stoker controls	See Particular Specification
2.8.5.1	Dual and multi-fuel burner controls	See Particular Specification
2.8.6.1	Electric boiler controls	on/off hi/lo/off multi-step
2.8.6.3	Electric boiler control	See Particular Specification
2.8.7.1	Abnormal multi-boiler control	See Particular Specification
2.8.7.4	Minimum flow rate through off-line boilers	See Particular Specification
2.9.2.4	Interconnection with circ. pumps	See Particular Specification
2.9.3.3	Abnormal reset requirements	None/See Particular Specification
2.10.2.1	Preheat control	a/b/see Particular Specification
2.10.3.1	Overheat control	a/b
2.11.1	Indicator lights and alarms—steam	a/b/c/d/e/f/g/h/j/k/l/m/see Particular Specification
2.11.2	Indicator lights and alarms- hot water	a/b/c/d/e/f/g/h/see Particular Specification
2.11.3	Audible and visual alarms — types — locations and information display	 See Particular Specification See Particular Specification
2.11.4	Remote audible and visual alarms Location Information display	 See Particular Specification See Particular Specification
2.11.5	Duty and standby power supplies	See Particular Specification
2.12.1	Chimney standard design life proprietary system liner types	BS4076/BS5854/see Particular Specification .....yrs acceptable/not acceptable steel/proprietary products
2.12.2	Gas fired boiler flues—types Flue to chimney connection	Steel single wall/Aluminium twin wall See Particular Specification
2.13.1	Damper location, type, damper/stoker interlock	See Particular Specification
2.14.1.1	Pressurisation type	a/b/c/d
2.14.2.1	Gas-pressurising method	a/b/c
2.14.2.8	Provision for compressed air	Reqd/l\lot reqd
2.14.3.3	Abnormal vessel	None/See Particular Specification
2.14.3.5	Duplicate pumps	Reqd/l\lot reqd
2.15.1.1	Water treatment	See Particular Specification

Clause	*Item	*Options/Requirements
2.15.1.3	MOD specialist advisor	....
2.15.1.8	Effluent treatment	See Particular Specification
2.15.1.11	Location of sample points— HTHW/MTHW/steam	See Particular Specification
2.15.1.12	Location of sample points— LTHW	See Particular Specification
2.15.1.13	Sample containers	See Particular Specification
2.15.1.14	Location of chemical stores Abnormal quantities	See Particular Specification
2.15.2.1	Pretreatment plant	See Particular Specification
2.15.2.2	Pretreatment for steam feedwater	See Particular Specification
2.15.2.3	Pretreatment for HTHW/MTHW	See Particular Specification
2.15.2.6	Abnormal regeneration time	See Particular Specification
2.15.3.1	Blow-down	Manual/intermittent/continuous
2.15.3.4	Abnormal blow-down rate Heat recovery plant	See Particular Specification
2.15.4.3	Tank capacities	See Particular Specification
2.15.5.1	Abnormal demin water spec.	.....(mg/litre)
2.15.5.2	LTHW systems fill water	See Particular Specification
Table 2A	Boiler types required in this contract	See Particular Specification
3.1.1.4	Test certificates	Reqd/Not reqd
3.1.1.5	Pumps and drives	Segregated/not segregated
3.1.1.7	Antivibration mountings	Reqd/Not reqd
3.1.2.3	Shaft seals	Dripless mechanical/packed gland
3.1.2.5	Antivibration mountings	Reqd/Not reqd
3.3.1	Condensate pumps casing	Centrifugal/see Particular Specification Cast iron/Gunmetal
3.3.8	Steam powered pumps	See Particular Specification
4.1.3d)	DHWS galvanised pipe	Reqd/Not reqd
4.1.3 f)	Galv. pipe for LPG	Reqd/Not reqd
4.1.3 g)	Galv. pipe for fire systems	Reqd/Not reqd

Clause	*Item	*Options/Requirements
4.1.5	BS 3601/ERW410 pipe wall thicknesses	Diameters and minimum thicknesses (mm): Dia:.....Thick:. ..... Dia:.....Thick:. ..... Dia:..... Thick:..... Dia:..... Thick:.....
4.2.1.4	Abnormal jointing	See Particular Specification
4.2.6.1	DHWS piping systems	Stainless steel/Copper/Galvanised steel
	Deadlegs	Stainless steel/Copper
4.2.6.3	Capillary fittings	Lead-free solder/End feed
4.2.7.1	Cold water service piping systems	Stainless steel/Polythene/PVC/ Other plastics/Copper/ Galvanised steel/See Particular Specification
4.2.8.2	Gas pipe bedding thickness	See Particular Specification
4.2.8.3	Buried steel pipe protection	See Particular Specification
4.2.10.2	Buried steel pipe protection Secondary containment	See Particular Specification Reqd/Not reqd
4.3.1	Abnormal welding requirements	See Particular Specification
4.3.3	Abnormal welding requirements	See Particular Specification
4.3.7	Abnormal welding requirements	See Particular Specification
4.4.1	Abnormal brazing requirements	See Particular Specification
4.4.3	Abnormal brazing requirements	See Particular Specification
4.4.5	Abnormal brazing requirements	See Particular Specification
4.4.7	Numbers of destructive brazing tests	.....
4.5.1.9	Pipe supports	See Particular Specification
4.5.3.1	Prestress	See Particular Specification
4.5.3.2	Expansion joint—type	See Particular Specification
4.5.3.4	Expansion joint—external protection	See Particular Specification
4.5.4.4	Automatic air vents	Malleable iron/nodular iron/ gunmetal/brass/none
4.5.5.5	HTHW drain valve sizes	Line size/drain size ...../..... ...../.....
4.5.5.6	Cleaning accesses	See Particular Specification
4.5.5.7	Steam and condensate main gradient	See Particular Specification
4.6.1	Abnormal pressure pipework Codes	See Particular Specification
4.6.5	Abnormal fittings	See Particular Specification
4.6.12	Welded return headers	Reqd/I\lot reqd

Clause	*Item	*Options/Requirements
4.6.13	Welded flow headers	Reqd/Not reqd
4.6.14	Flow and return headers No of spare ways	See Particular Specification
4.7.1	Below ground distribution pipework	See Particular Specification
Table 4A	Steel pipe wall thickness Polyethylene class PVC class	.....mm ....
Table 4B	Steel pipe wall thickness	.....mm
5.1.1	Storage calorifiers	Grade A/Grade B
5.1.2	Non-storage calorifiers	BS 3274/Type 2/BS 853 Grade A
5.1.4	Bursting disc and safety valve pressures	See Particular Specification
5.1.5	Valves	AFRI/NRV
5.1.7	DHWS non-storage calorifiers	Galvanised/made of copper
5.1.8	DHWS Storage Calorifiers Sacrificial Anodes	Galvanised/Copper-lined/made of copper Reqd/Not reqd
5.1.11	Spare tube and plate assemblies	Reqd/Not reqd
5.1.14	DHWS parallel secondary arrgt.	See Particular Specification
5.2.1a)	Steel Cylinders	BS417 Part 2, Grade A/Grade B
5.2.1b)	Copper Cylinders	BS 699 Grade 1/Grade 2
5.2.3	Sacrificial Anodes	Reqd/Not reqd
5.4.5	Plinths	See Particular Specification
5.5.1	Tanks	a/b/c/d/e/f/see Particular Specification
5.5.2	Sacrificial Anodes	Reqd/Not reqd
5.5.5	Valve sizes	See Particular Specification
5.5.8	Supports for cisterns	Main Contractor/Contractor
5.5.10	Multiple tanks arrgt. Partial service	Series/parallel Reqd/Not reqd
5.6.1	Aeration prevention	See Particular Specification
5.7.1	Steam injection Tank	See Particular Specification Austenitic/Carbon steel
6.1.1	Radiators—types, operating temperatures, ratings, etc surface areas feet	See Particular Specification See Particular Specification Reqd/Not reqd
6.2.1	Convectors—types, ratings, etc	See Particular Specification
6.2.2	Abnormal Casings requirements	See Particular Specification
6.2.9	Fan convectors Noise Ratings	NR.....

Clause	*Item	*Options/Requirements
6.2.11	Gas fired convectors	See Particular Specification
6.3.1	Perimeter heaters—types, ratings, etc	See Particular Specification
6.3.2	Perimeter heating Other services Control dampers Sound baffles	 See Particular Specification Reqd/not reqd Reqd/not reqd
6.4.1	Radiant panels—types, ratings, dimensions, etc	See Particular Specification
6.4.5	Radiant panels—arrangement	See Contract Drawings
6.4.8	Radiant/convective floors/ceilings	See Particular Specification
6.4.9	Gas fired radiant heaters	See Particular Specification
6.5.1	Unit heaters—ratings, conditions, etc	See Contract Drawings
6.5.5	Unit heaters Noise Rating	NR ...../See Particular Specification
6.5.8	Unit heaters Auto control—type and method	See Particular Specification .....
6.6.1	Steam heater traps	Globe valve/Full-way valve
	Pockets and sight glasses	See Particular Specification
7.1.1	Abnormal copper alloy	See Particular Specification
7.1.4	Lockable valves location	See Particular Specification
7.1.7	Valves	See Particular Specification
7.2.2	Safety valve sizes	See Contract Drawings
7.2.5	Safety valves Discharge connections to drains	See Contract Drawings
7.3.1 c)	Valve bodies	Bronze/nodular iron
7.3.2	Pressure gauges	Reqd/not reqd
7.4.1	Valve materials	Gunmetal/bronze/cast iron/steel
7.5.1	LTHW radiator valves	a/b/c
7.6.4	Regulating valves	See Particular Specification
7.7.2	Commissioning valves	a/b/c
7.8.1	LTHW and MTHW valves DN65 plus	Copper alloy/Cast iron
7.8.4	Valve opening method	Direct/Indirect
7.8.7	Water meter	Reqd/I\lot reqd.
7.8.8	Check valves	See Particular Specification
7.8.9	MTHW valves	a/b/a and b
7.9.1	HTHW valves to DN50	Bronze/gunmetal/iron/steel
7.9.3	Valve opening method	Direct/Indirect

Clause	*Item	*Options/Requirements
7.9.4	Check valves—HTHW	Steel lift/steel swing/gunmetal swing
7.9.5	Valves with packless glands or bellow seals	See Particular Specification
7.10.1	Steam valves	Copper alloy/steel
7.10.6	Check valves	See Particular Specification
7.11.3	Isolating valves—condensate	See Particular Specification
7.11.4	Condensate system check valves	See Particular Specification
7.12.3	Drain valves	Reqd/Not reqd.
7.12.4	Taps in separate contract Connection to draw-off	See Particular Specification Copper/polyethylene
7.12.5	Urinal solenoid valves	See Particular Specification
7.13.1	Gas valves	a/b/c/d/e/f/g/See Particular Specification
8.1.3	Control medium	Electric/electronic/pneumatic/self acting/See Particular Specification
8.1.6	BEMS	See Particular Specification
8.2.1.1	Primary temperature control	a/b/c/See Particular Specification
8.2.1.2	On/Off sensor location Control action	See Particular Specification See Particular Specification
8.2.1.3	Modulating sensor location Control action	See Particular Specification See Particular Specification
8.2.1.4	Weather compensation	See Contract Drawings
8.2.1.5	Weather compensator sensor location(s) Control valves	See Contract Drawings See Contract Drawings
8.2.2.1	Time control method	a/b/See Particular Specification
8.2.2.4	Supplementary programmes	See Particular Specification
8.2.2.5	Abnormal programmes	See Particular Specification
8.2.2.6	Clock contacts Boost facilities	Reqd/Not reqd See Particular Specification
8.2.2.8	Optimum start control Sensor locations	 See Contract Drawings
8.2.2.9	Optimum off	Reqd/Not reqd
8.2.3.1	Space temperature control	a/b/c/d/See Particular Specification
8.2.3.2	Sensor locations and control method	See Particular Specification
8.2.3.3	Sensor location	See Particular Specification
8.2.4.2	Adjustable thermostats	See Particular Specification
8.2.4.3	Non-adjustable thermostats	See Particular Specification
8.2.5.2	Heating calorifier modulating control method	See Particular Specification
8.2.7.4	Abnormal element location	See Particular Specification

Clause	*Item	*Options/Requirements
8.2.7.6	Clock control	Reqd/Not reqd
8.3.1.1	Controller types	a/b/c/d/See Particular Specification
8.3.1.2	Controller enclosure	See Particular Specification
8.3.4.2	Controller—sensor regimes	See Particular Specification
8.4.1.1	Enclosure standard	IP...../See Particular Specification
8.4.2.1	Indicator lamp types	a/b/c/d/See Particular Specification
9.3.1	Steam traps	a/b/c/d/e/See Particular Specification
9.3.5	Steam traps—leak detector method	a/b/See Particular Specification
9.4.1	Strainers—locations	See Particular Specification
9.4.4	Strainers—duplex	See Particular Specification
9.5.4	Shower isolating valves Automatic drain valves	See Particular Specification Reqd/Not reqd
9.5.5	Manual mixing valves	See Particular Specification
9.5.6	Abnormal shower requirements	See Particular Specification
9.6.1	Abnormal primary gas meter provision	See Particular Specification
9.6.2	Secondary gas meters location and duties	See Particular Specification
9.7.1.1	Platforms, access, etc	See Particular Specification
9.7.1.2	Platforms, access, etc Painting spec	See Particular Specification
9.7.2.2	Platforms, access, etc Abnormal design floor loads	See Particular Specification
9.7.3.1	Platforms, access, etc Abnormal handrail design loads	See Particular Specification
10.1.2	Thermal insulation environment	See Particular Specification
10.1.4	Thermal insulation in circulation spaces Class 1 insulating materials	See Particular Specification See Particular Specification
10.1.7	Abnormal insulation thicknesses	See Particular Specification
10.1.8	Anti-condensation insulation	See Particular Specification
10.2.1.1b)	Additional pipework insulation	See Particular Specification
10.2.1.1d)	Cisterns etc to be insulated	See Particular Specification
10.2.1.1e)	Abnormal insulation	See Particular Specification
10.2.1.3	Abnormal insulated pipe locations Abnormal requirement for insulation	See Particular Specification See Particular Specification
10.2.2C)	Expansion devices to be insulated	See Particular Specification
10.4.2.1	Insulation finish on vessels	Aluminium/Galvanised steel

Clause	*Item	*Options/Requirements
10.4.2.2	Insulation finish on pipework	Aluminium/Galvanised steel/plastic/See Particular Specification
10.4.2.4	Insulation casings Abnormal bends and tees	See Particular Specification
10.4.3.1b) and c)	Concealed pipework to be Pre-insulated	See Particular Specification
10.4.3.2	Visible pipework finishes	a/b/c/See Particular Specification
10.4.4.2	Weatherproof finishes	a/b/c/d/e/f/See Particular Specification
10.4.5.1	Insulation paint colour scheme	See Particular Specification
10.4.6.1	Pipe service identification band locations	See Particular Specification
11.1.1	Abnormal electrical work	See Particular Specification
11.1.3	Electrical equipment Abnormal ambient conditions	 See Particular Specification
11.2.1	Abnormal phase number	See Particular Specification
11.2.3	Abnormal electrical enclosure standards	See Particular Specification
11.3.1	Starter types and ratings	See Particular Specification
11.3.3b)	Emergency stop button	Reqd/Not reqd
11.4.2	Cable entries	Conduit/Mineral insulated cable
11.5.1	Immersion heater supply Ratings	Contractor/Others See Particular Specification
11.6.1	Power supply to convectors	By Contractor/by others
11.8.1	Abnormal test certificates	See Particular Specification
12.1.1	The Competent Person	Messrs..... .... Tel .....
12.4.1	Items to be inspected	See Particular Specification
12.1.4a)	Boilers	See Particular Specification
12.1.4b)	Pressure vessels	See Particular Specification
12.1.4d)	Mains	See Particular Specification
12.1.4e)	Fuel tanks	See Particular Specification
12.1.4f)	Chimneys and flues	See Particular Specification
12..1.4g)	Other Pressure Systems	See Particular Specification
12.1.4h)	Other installations	See Particular Specification
12.3.7	Hot water heating cleaning spec	Contractor to provide/See Particular Specification

Clause	*Item	*Options/Requirements
12.3.8	DHWS and CWS cleaning spec	Contractor to provide/See Particular Specification
12.4.3	Treatment after hydraulic test	See Particular Specification
12.4.5	Hydraulic test pressure	1.5 times the working pressure/ 7 bar
12.4.8	Test before insulation	Yes/No
12.5.2	Abnormal provisions for testing	See Particular Specification
12.6.1	Abnormal commissioning codes	See Particular Specification
12.6.2	Commissioning	By Contractor/ By independent specialist/ By nominated specialists: .... Tel .....
12.6.5	Abnormal certifying signatures	.....
12.7.3	HTHW and MTHW boiler testing	By independent specialist/ By nominated specialists: .... Tel .....

Schedule No. 2—Information to Be Supplied by the Tenderer

	*Items	*Details	Country of Origin
1.	BOILERS		
	(a) Manufacturer	.....	
	(b) Catalogue Ref.	.....	
	(c) Rated Output	.....kW	
2.	FIRING EQUIPMENT		
	(a) Manufacturer	.....	
	(b) Catalogue Ref	.....	
	(c) Fuel	Mono/dual/multi solid/gas/oil BS 2869: Part 2 Class D/F/G	
	(d) Type of control	On-off/high-low-off/fully modulating	
	(e) Turn-down ratio	.....:1	
3.	BOILER CONSTRUCTION STANDARD	BS	
4.	GAS SIDE RESISTANCE		
	(Between firing equipment and boiler exit)	.....mbar	
5.	FLUE DRAUGHT REQUIRED AT BOILER EXIT	.....mbar	
6.	MAXIMUM HYDRAULIC RESISTANCE (Between the flow and return connections of hot water boilers when operating at rated output and design temperature differentials)	.....mbar	
7.	STEAM DISENGAGEMENT VELOCITY	.....m/s	

***Items**	***Details**	**Country of Origin**

8. STEAM MINIMUM DRYNESS FRACTION ..... %

9. RADIATION LOSS AT RATED OUTPUT .....%

10. SHELL BOILERS

(a) Furnace tube dimensions

Length ..... mm

Internal diameter ..... mm

(b) Smoke tubes

	Plain	Stay
Number	.....	.....
Internal diameter	..... mm	..... mm

(c) Heat release rate to furnace tube (Note A) ..... kW/m^3

(d) Calculated maximum gas temperature in reversal chamber (Note B) ..... °C

(e) Calculated hot face metal temperature in reversal chamber tube plate (Note C) ..... °C

NOTES:

A The heat release rate to the furnace tube shall be taken as the heat input based on gross calorific value of the fuel required to give rated output at an efficiency of 80% divided by the furnace tube volume.

B The maximum gas temperature shall be as calculated in BS 2790.

C The hot face metal temperature shall be as calculated in BS 2790.

11. GROSS THERMAL EFFICIENCY

(a) At rated output ..... %

(b) At 50% output ..... %

(c) At minimum output ..... %

12. OIL STORAGE	Maker	Size, rating or catalogue ref
(a) Oil tanks	.....	.....
(b) Contents gauge	.....	.....
(c) Tank or outflow heater	.....	.....
(d) Oil circulating pump	.....	.....

13. HOT WATER PRESSURISING UNIT

(a) Maker .....

	*Items	*Details	Country of Origin
	(b) Type	.....	
	(c) Method of sealing spill tank	.....	
14.	WATER TREATMENT PLANT		
	(a) Maker	.....	
	(b) Catalogue Ref	.....	
	(c) Rated capacity	.....	
15.	CHEMICAL CONDITIONING EQUIPMENT		
	(a) Manufacturer	.....	
	(b) Mixing tank capacity	.....	
	(c) Dosing pump type	.....	
16.	INSTRUMENTATION	Maker ..... Catalogue ref	
	(a) Multi-point temperature indicator	....	
	(b) Meter (Make-up water)	....	
17.	CIRCULATING PUMPS	Maker Catalogue ref	
	Pump No. 1	....	
	2	....	
	3	....	
	4	....	
	5	....	
	6	....	
	7	....	
	8	....	
18.	BOILER FEED PUMPS		
	Pump No. 1	....	
	2	....	
	3	....	
	4	....	
19.	CONDENSATE PUMPS/RECEIVERS	....	
20.	SEMI-ROTARY PUMPS	....	
21.	OIL CIRCULATING/TRANSFER PUMPS	....	

*Items	*Details	Country of Origin
22. PIPEWORK, SPECIAL EXPANSION JOINTS		
(a) Maker	.....	
(b) Type	.....	
23. CALORIFIERS (STORAGE)		
(a) Maker	.....	
(b) Material	.....	
(c) BS	.....	
24. CALORIFIERS (NON STORAGE)		
(a) Maker	.....	
(b) Material	.....	
(c) BS	.....	
25. CYLINDERS (DIRECT)		
(a) Maker	.....	
(b) Material		
26. CYLINDERS (INDIRECT)		
(a) Maker	.....	
(b) Material	.....	
27. PLATE HEAT EXCHANGERS		
(a) Maker	.....	
(b) Material	.....	

*Items		*Details	Country of Origin
28. SPACE HEATING EQUIPMENT	Maker	Size, rating or catalogue ref	
Radiators	.....	.....	
Convectors, natural	.....	.....	
Convectors, fan	.....	.....	
Perimeter heaters	.....	.....	
Radiant panels	.....	.....	
Radiant strips	.....	.....	
Radiant ceilings	.....	.....	
Underfloor heating	.....	.....	
Unit heaters	.....	.....	
(State type (a), (b) or (c). See Clauses 6.5.2 and 6.5.3. If Type (c) gives details of anti-corrosion protection)	.....	.....	

	*Items		*Details	Country of Origin
29.	VALVES	Maker	Type and/or catalogue ref	
	Safety or relief	.....	.....	
	Pressure reducing	.....	.....	
	Thermostatic control	.....	.....	
	Radiator	.....	.....	
	Thermostatic radiator	.....	.....	
	Regulating	.....	.....	
	Double regulating	.....	.....	
	System balancing	.....	.....	
	Globe	.....	.....	
	Gate	.....	.....	
	Parallel slide	.....	.....	
	Butterfly	.....	.....	
	Ball	.....	.....	
	Lubricated plug cock	.....	.....	
	Ball float	.....	.....	
	Diaphragm	.....	.....	
	Check	.....	.....	
	Gland cocks	.....	.....	
30.	SPACE HEATING CONTROLLER	.....	.....	
31.	TIME PROGRAMME CONTROL SYSTEM	.....	.....	
32.	CONTROL CUBICLE/PANEL	.....	.....	
33.	MISCELLANEOUS			
	Thermometers	.....	.....	
	Pressure gauges	.....	.....	
	Steam traps	.....	.....	
	Hot and cold water mixing valves	.....	.....	
34.	THERMAL INSULATION	Maker	Type and/or catalogue ref	
	Preformed rigid	.....	.....	
	Declared thermal conductivity	.....	.....	
	Weatherproof finish	.....	.....	

*Items	*Details	Country of Origin
35. OTHER EQUIPMENT	.....	
36. COMMISSIONING		
By Contractor	Yes/No	
By Commissioning Specialist	Name:	
37. BOILER PERFORMANCE TEST		
By Contractor	Yes/No	
By independent specialist/Company	Name:	
38. DRAWINGS/PAMPHLETS SUPPLIED WITH TENDER	.....	
	.....	

Signed (as in Tender) ....

For and on behalf of..... Date .....

If you have comments on this document please fill in a photocopy of this form and send it to DEO (Works).
Please do not use the shaded areas of the form.

DEFENCE ESTATE ORGANISATION	**Defence Organisation** **Industrial Group (M&E)** **Blakemore Drive** **Sutton Coldfield** **West Midlands** **B75 7RL**	**Specification 035** **Heating, hot and cold water, steam and gas installations** **Change Suggestion Form**
Originator:		Date:
		Reference:
Change Suggestion		
Section/Clause/Sub-clause or Annex/Paragraph N°.		Page N°s:
Change Detail: Continuation Sheet included ? Y☐ N☐		
Reason: Continuation Sheet included ? Y☐ N☐		
DEO Review		
Action:		**Reference:**
		Action Date:
		Approved:
		Actioned:

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